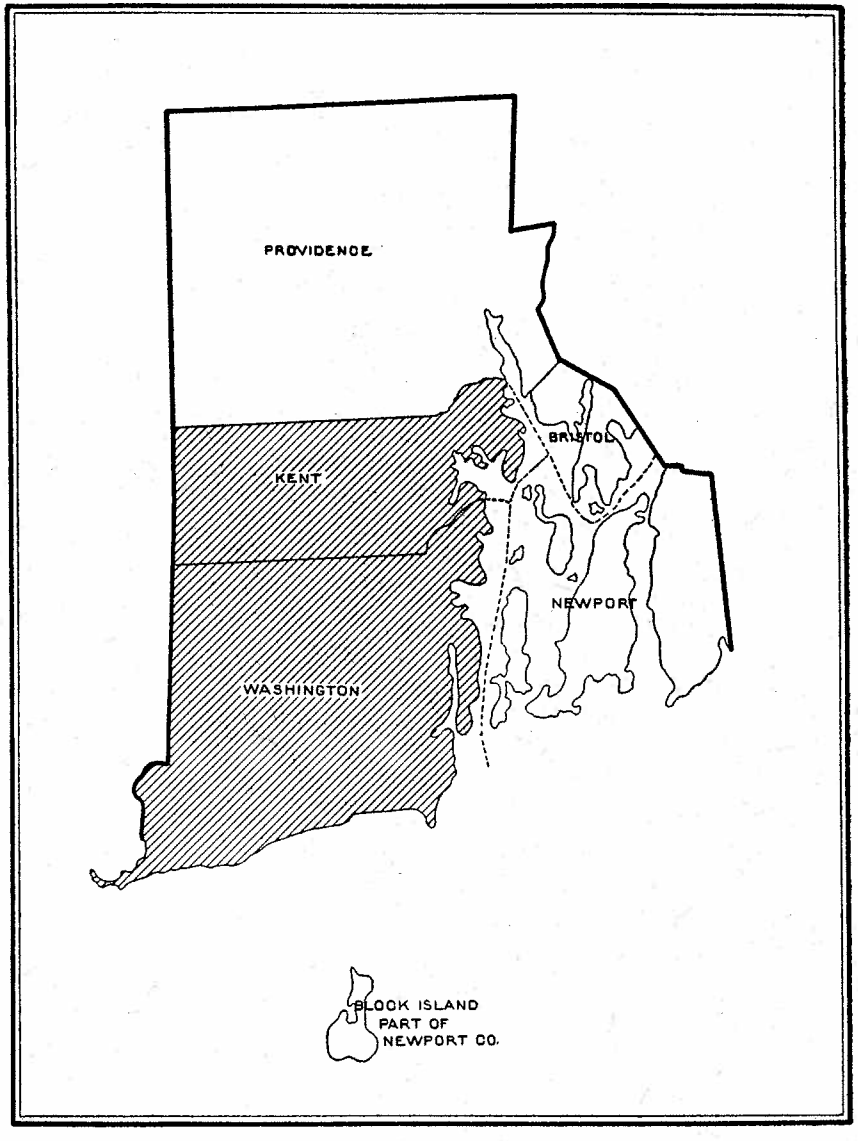

Areas surveyed in Rhode Island shown by shading.

Soil Survey

Series 1934, No. 9. Issued February 1939

Kent and Washington Counties Rhode Island

GEOLOGICAL SCIENCES
California Institute of Technology

By
R. C. ROBERTS
United States Department of Agriculture, in Charge
and
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Rhode Island Agricultural Experiment Station

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Authority for printing soil survey reports in this form is carried in the Appropriation Act for the Department of Agriculture for the fiscal year ending June 30, 1933 (47 U. S. Stat., p. 612), as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than two hundred and fifty copies shall be for the use of each Senator from the State and not more than one thousand copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.

Series 1934, No. 9 Issued February 1939

SOIL SURVEY OF KENT AND WASHINGTON COUNTIES, RHODE ISLAND

By R. C. ROBERTS, United States Department of Agriculture, in Charge; and H. C. KNOBLAUCH, S. V. MADISON, and V. A. HENDRICK, Rhode Island Agricultural Experiment Station

COUNTIES SURVEYED

Kent and Washington Counties comprise most of the southern half of Rhode Island (fig. 1). The area is roughly rectangular in shape. The greatest distance from north to south is about 28 miles, and the greatest distance from east to west is about 22 miles. Kent County, on the north, includes an area of 174 square miles, and Washington County, on the south, has an area of 325 square miles, making a total area of 499 square miles, or 319,360 acres. A detailed soil survey was made of these counties during the summer seasons of 1932 to 1934. A previous soil survey [1] of the entire State was made in 1904, but since that time much additional knowledge of soil development has been acquired, and it was deemed desirable to make a resurvey of the State. A comparison of the first report with the present one will show that agricultural conditions have changed considerably since 1905 and that soil boundary lines and soil names on the soil map

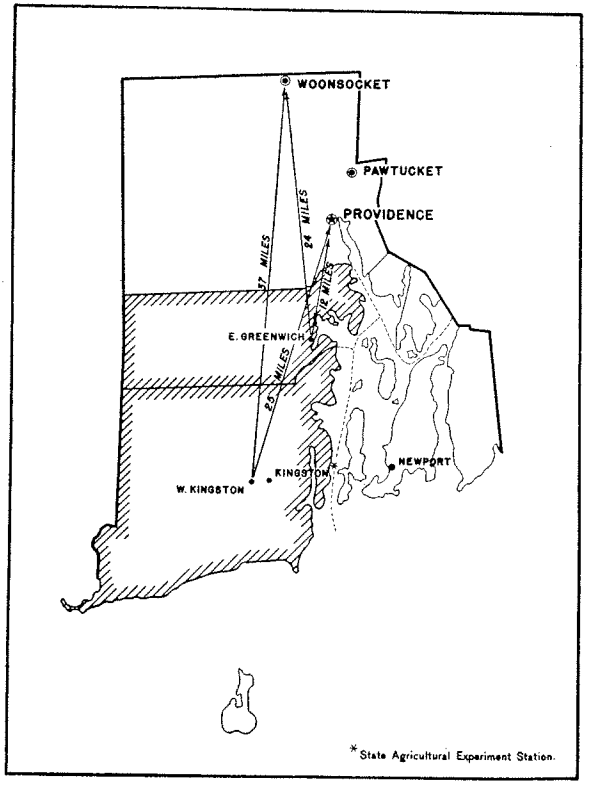

FIGURE 1.—Sketch map showing location of Kent and Washington Counties, R. I.

[1] BONSTEEL, F. E., and CARR, E. P. SOIL SURVEY OF RHODE ISLAND. U. S. Dept. Agr., Bur. Soils Field Oper. 1904. Rept. 1: [47]–72, illus. 1905.

are now, in the light of later knowledge, very different from the original survey.

The land area of Kent and Washington Counties comprises two distinct physiographic divisions—the eastern or Narragansett Basin division and the western hilly division.

The Narragansett Basin division comprises an area of relatively smooth low hills and glacial plains adjacent to the bay, which extends inland for a distance not exceeding 3 miles. The relief consists of fairly smooth rounded hills of gradual slope, not exceeding 250 feet in height, and of nearly level or gently rolling glacial plains, which are especially prominent in the northeastern part of Kent County. In this division the hills are composed largely of schists, shales, and conglomerates which in many places have been overlain by glacial till of coarser materials, although the soils show the influence of the underlying finer grained rocks. Most of the soils on these hills, although stony, are of a loam texture. They are the best upland soils in the two counties for general farm crops, especially hay and grass. Most of the glacial plains have a nearly level relief with a few areas that are undulating or rolling. The texture of the soils on the plains ranges from loamy sand to silt loam, and the soils are used very extensively for truck and general farm crops. The finer textured members are the best agricultural soils of the area surveyed, especially for potatoes. The occurrence of stratified coarse gravel and rounded water-worn boulders in these plains indicates strong glacial or subglacial currents and the transportation of materials from the granite hills to the north and west. The fine-textured soils of the plains, free from rocks, indicate deposition in quiet or slow-moving water and also a possibility that much of this material was contributed from the adjoining shale and schist hills.

The bedrocks of the Narragansett Basin division consist mostly of shales and coals of the Carboniferous period, which give rise to the soils of the Newport series. Lying on the extreme western edge of this division and adjacent to the coarse-grained rocks of the western hilly division is a narrow belt of fine-grained granite and schist, the weathered material of which forms the Narragansett series. The geologic evidence indicates that this basin, especially the eastern part, was an ancient erosion trough, formed before the Carboniferous age, in which the carboniferous deposits accumulated during subsidence and later were compressed and tilted.

The western hilly division covers approximately the western two-thirds of the area surveyed, and consists of rough stony hills, ranging in height from 100 to more than 600 feet, and of narrow U-shaped valleys. Despite their moderate elevation, these hills present a decidedly mountainous appearance, and much wild game thrives. This division is probably the remnant of an ancient mountain range, which has been subjected to long-continued erosion and repeated glacial invasions. Most of the slopes are steep, and in places the glacial till is lacking and the bare igneous bedrock is exposed. Such areas are nonagricultural and are used only for forest. Another feature of these hills is that they have nearly flat instead of sharp crests. This flattening of the hilltops probably is

the result of the grinding and shearing work of glaciers, and such destructive action is probably the cause of much of the materials being deposited at lower levels as moraines and eskers, which, in turn, have been reworked by stream action, forming the few glacial plains in these sections. Some of the level upland areas have been cleared of their surface stones and planted to general farm crops and orchards. The rocks of this section consist of granite, gneiss, mica schist, and hornblende schist, most of which are of great geologic age and include a complicated variety of igneous intrusions.

It is probable that all of the area surveyed has been glaciated more than once. The till, or glacial covering averaging about 10 feet, is thicker than it is farther north but not so thick as in the Central States. In Rhode Island the glacial till contains less clay than the till of the Central States, partly because Rhode Island was a marginal district of glaciation. Most of the till material was formed from eskers and washed sands and gravels that already had been worked by the ice and the finer material lost.

The river valleys throughout the area surveyed, as well as throughout the remainder of the State, contain very little alluvial material. Terraces consisting of very fine sandy loam, fine sandy loam, sand, and gravel occupy most of the valleys.

Most of the drainage of Washington County is effected through Pawcatuck River and its tributaries which flow south to the Atlantic Ocean. Most of the drainage in Kent County flows east through Potowomut and Pawtuxet Rivers to Narragansett Bay. These streams do not seem to have much fall, although many water mills have been operated along both the large streams and the small ones, throughout the area surveyed. Long narrow swamp areas occur along many of the streams, and some swamps, like Great Swamp, Indian Cedar Swamp, and the swamp near Westerly, occupy basin areas covering more than 1,000 acres each. Most of the swampland supports a thick growth of maple, birch, or swamp cedar, and the soil materials are muck, peat, or poorly drained mineral soil. After heavy rains the streams passing through the swamp areas are colored by dissolved organic matter. All the inland swamps contain fresh water, but many salt-water ponds and salt-water marshlands are near the seacoast.

Kent and Washington Counties include many lakes and ponds, the largest of which is Worden's Pond. Most of the lakes and ponds are very scenic, and many summer cottages, resorts, and beautiful homes are located on their shores. Some of these ponds, especially those in the terminal moraine of the southeastern part of Washington County, are from 30 to 40 feet deep; but others, like Worden's and Watchaug Ponds, are only 5 or 6 feet deep, except for a few deeper holes. Some of the lakes and ponds are used as water supply reservoirs for town use, as Carr Pond near East Greenwich. Flat River Reservoir and Quidnick Reservoir supply water to the mills between Washington and River Point. All of the ponds, with the exception of Larkins, Long, Cedar Swamp, White, Wash, and Deep Ponds, have natural outlets either through swamps or streams. Most of them have sandy bottoms, contain clear fresh water, and are desirable places for bathing, boating, and fishing.

The elevation of the two counties ranges from sea level to a maximum of 610 feet on Bowen Hill in the northwestern corner of Kent County.[2]

The forest on the rough stony land of the western hilly division consists mostly of hemlock and of white, black, and red oaks; and that on the less rough land, of oak, chestnut, and poplar. On the sandier hills of the western division the dominant trees are conifers, mostly white pine with some pitch pine, and on the coarse sandy plains pitch pine is predominant. In the valleys, swamp maple grows on the mineral soils and swamp cedar on the deep muck. Holly trees are fairly numerous in Great Swamp. Along Narragansett Bay the forest flora consists mostly of white, black, and red oaks; chestnut; sassafras; honeylocust; and elm. The soils and climate are favorable for these trees. In areas where the forest consists mostly of conifers, the land supports little or no underbrush, but in areas supporting hardwood trees, the underbrush is usually dense and consists of shrubs, sprouts from older trees, and young trees. On cut-over and burned-over land the new growth is about the same as the previous stand. Usually oaks come in very thickly, causing a stunted growth until some are killed by natural elimination. The shrubs most commonly found on the higher land are sumac, blueberries, raspberries, sweetfern, dogwood, and laurel. Bayberry is very common near the coast. The swamps support an undergrowth of ferns, clubmoss, rhododendron, bull brier, and some laurel.

The common grasses are the fescues, broomsedge, Rhode Island bentgrass, redtop, poverty oatgrass (*Danthonia spicata*), Kentucky bluegrass, and Canada bluegrass. The most prevalent weeds are wild mustard, quackgrass, poison-ivy, sorrel, daisies, barnyard grass, and crabgrass.

Most of the farm water supply comes from the numerous springs and streams, and the household supply is obtained from open wells which range in depth from 10 to 30 feet. An unlimited supply of good water can be obtained in any part of the two counties.

Rhode Island has the highest average density of population of any State in the Union, but game and game birds are plentiful on the large tracts of wooded land, on the many large estates and private game preserves, and along the coast and on many of the ponds. The Kimball Bird Sanctuary, containing about 30 acres of land, is situated in the southern part of Washington County near Watchaug Pond, and here, as elsewhere, wild birds of many kinds are plentiful. Fish are fairly abundant in the inland streams. Many oysters, clams, lobsters, and scallops are obtained from the shores and nearby waters of Narragansett Bay, and the shellfish industry gives employment to many persons.

Within the two counties are several beautiful parks and many interesting historic places. There are many country clubs with golf courses, polo grounds, and tennis courts. Watch Hill and Narragansett Pier are known the world over as summer resorts, and there are many other beautiful beaches. Many small free public picnic grounds with fireplaces, maintained and supplied with firewood by the State Highway Department, along some of the main highways,

[2] Elevations from U. S. Geological Survey topographic sheets.

not only are enjoyed by thousands of persons but undoubtedly prevent many forest fires.

Richard Smith, who located at Cocumcussoc in 1641, probably was the first settler in what is now North Kingstown, and the house he built was one of the few not burned by Indian raiders before and during King Philip's War. Washington County, originally called Narragansett County or Old South County, was incorporated June 16, 1729, as King's County. The name was changed to Washington County October 29, 1781. Kingston, a small village in Washington County, is the location of Rhode Island Agricultural Experiment Station and Rhode Island State College. Kent County, which was originally part of Providence County, was incorporated June 11, 1750. Westerly, with a population of 10,997 in 1930, is the largest and most important city in Washington County. It is a manufacturing town and summer resort. Wakefield, the second largest town in the county, had a population of 4,000 in 1930. West Kingston is the county seat. Warwick, the largest town in Kent County, having a population of 23,196 according to the 1930 Federal census, is the location of numerous manufacturing plants. East Greenwich is the county seat, and had a population of 3,666 in 1930.

Transportation facilities are good. The main line of the New York, New Haven & Hartford Railroad traverses the area connecting most of the larger towns. A branch line extends from West Kingston to Narragansett Pier, and the Wood River Branch extends from Wood River Junction to Hope Valley and Locustville. A few electric interurban railway lines are still in operation, and bus lines connect practically all towns in the two counties. The public roads are kept in good condition, and a number of two- to four-lane surfaced State roads cross the area in several directions. Many of the county and town roads are surfaced or graveled, and the secondary roads are fair to good during most of the season. The two counties have several large airports within their limits. About one-half of the farms have telephones, and nearly every farmer has an automobile. Every community has adequate schools, churches, and free mail service, and nearly every town has a public library.

The manufacturing industries give employment to more than 10,000 persons in the two counties, and this large number of employees creates a ready market for local farm products. The industries employing the largest number are the cotton, silk, woolen, and other textile mills; the building industries; and the wholesale and retail trades.

CLIMATE

The climate of Kent and Washington Counties is typical of the southern part of the New England States. Because of the proximity of the ocean and of Narragansett Bay the climate is modified and warmed in winter and correspondingly is cooled in summer. The precipitation is uniformly distributed over the seasons. Usually the available moisture supply is sufficient for the growth of crops, and drought is an exception, although during the summer of 1934 many crops suffered, and crop yields were reduced because of lack of moisture. The climatic conditions are favorable to the growth of

general farm crops, to market gardening, to orcharding, and to livestock raising.

The average length of the frost-free season at Kingston is 161 days—from May 2 to October 10—and in most years is ample for the maturing of all crops commonly grown. Frost has been recorded at this station as late as May 26 and as early as September 11. In some of the valleys, especially in the western part of the county, killing frosts usually occur somewhat earlier in the fall and later in the spring than in other parts, and sometimes injure truck crops and fruit. Records of the United States Weather Bureau station at Providence give the average dates of the latest and earliest killing frosts as April 18 and October 22, respectively, and the latest and earliest recorded frosts as May 10 and September 23.

The fairly cool summer climate combined with beautiful, easily accessible beaches and scenic lakes, makes this area a very popular summer resort. The tourist season begins about the latter part of June and ends soon after Labor Day. The trade thus created is an important source of income.

Tables 1 and 2 give the more important climatic data as recorded by the United States Weather Bureau stations at Providence and Kingston which are fairly representative for the two counties.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Providence, Providence County, R. I.*

[Elevation 160 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1846)	Total amount for the wettest year (1898)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	31.6	68	−12	3.38	3.15	2.54	5.5
January	27.2	64	−9	3.70	1.82	6.01	9.1
February	29.0	62	−10	3.64	2.08	6.45	9.7
Winter	29.3	68	−12	10.72	7.05	15.00	24.3
March	35.7	79	5	3.49	2.86	2.95	6.0
April	46.6	86	20	3.21	1.75	6.08	2.2
May	58.5	92	32	2.96	4.58	4.07	Trace
Spring	46.9	92	5	9.66	9.19	13.10	8.2
June	68.3	94	42	2.68	1.30	1.16	0
July	73.4	100	51	3.27	1.44	10.26	0
August	71.0	97	46	3.50	2.73	6.00	0
Summer	70.9	100	42	9.45	5.47	17.42	0
September	63.2	92	33	3.18	2.33	2.26	0
October	52.2	85	27	3.12	1.85	8.43	0
November	40.4	75	12	3.06	4.62	7.29	.7
Fall	51.9	92	12	9.36	8.80	17.98	.7
Year	49.8	100	−12	39.19	30.51	63.50	33.2

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Kingston, Washington County, R. I.*

[Elevation, 100 feet]

Month	Temperature	Precipitation		
	Mean	Mean	Total amount for the driest year (1930)	Total amount for the wettest year (1898)
	°F.	*Inches*	*Inches*	*Inches*
December	30.7	4.84	4.16	2.71
January	27.3	4.85	3.37	6.83
February	26.8	4.47	4.15	8.13
Winter	28.3	14.16	11.68	17.67
March	35.1	4.78	2.84	3.71
April	44.4	4.65	1.70	5.56
May	54.7	4.05	3.45	8.95
Spring	44.7	13.48	7.99	18.22
June	63.5	3.33	2.50	.77
July	69.0	3.50	3.35	7.11
August	67.6	4.38	2.49	6.85
Summer	66.7	11.21	8.34	14.73
September	61.9	3.55	1.39	2.11
October	51.8	4.17	2.92	12.05
November	40.7	4.26	3.75	7.44
Fall	51.5	11.98	8.06	21.60
Year	47.8	50.83	36.07	72.22

AGRICULTURE

The agricultural history of these counties dates from about 1640. At that time the relations between the settlers and the neighboring Narragansett Indians were very friendly, and it was this friendly feeling, which was maintained for a long time, that enabled the first settlers to prosper. The Narragansett Indians controlled nearly all of Rhode Island west of Narragansett Bay before the coming of the white settlers. It was chiefly men from Massachusetts and Connecticut, not those from Rhode Island, who fought against the Indians in King Philip's War, as they were seeking the hostile Wampanoags ruled by Massasoit.

Shipbuilding for commerce with the West Indies was an early industry in Rhode Island. The traders would take New England rum, flour, and other products to Africa, trade for slaves, then sell the slaves in the West Indies to sugar planters. Here they would get molasses to make more rum at home. Other products sold included dried fish, butter, cheese, beef, mutton, and general farm produce. The Narragansett pacers were in great demand on the sugar plantations of the West Indies, both as work horses to turn the horse-drawn roller mills and as easy-gaited saddle horses for the plantation owners and their families.

The colonial system of farming was developed extensively in Rhode Island, especially near Narragansett Bay, and some of the colonial estates were several square miles in extent, but the average size of the farm was about twice that of the farm of today, or about 300 acres. The clearing of the land of stones and trees was a very

slow process, and as the fields were cleared the stones were built into stone walls, many of which are still standing. Most of the labor on the farm was performed by African slaves, although some labor was performed by the Narragansett Indians. Slavery was gradually abolished after 1784.

Indian corn and tobacco were the first crops grown. During the early agricultural period very little produce was exchanged between communities, and trading was chiefly with the Indians. The settlers produced practically all of their own necessities. Rhode Island was famous for its fine horses, good cheese, and large quantities of excellent wool. After 1800, with the beginning of manufacturing in the towns and villages, farming became more of a commercial business, as the farmers supplied the needs of people in the towns. Agriculture in this part of New England advanced rapidly until about 1875, but since then, it has steadily decreased year after year. This decrease has been due to the rapid settlement of the West after 1850, since which time western produce has competed against that grown in the East. Because of rapid progress in railroad transportation from 1880 to 1900 the East was decidedly at a disadvantage when trying to compete with the larger scale farming and the more productive and more easily tilled land of the West. Also during this time manufacturing in the East was expanding and agriculture was becoming of secondary importance. In 1880, according to the Federal census, 80 percent of Washington County was in farms, and in 1930 only 41.8 percent was in farms, but in 1935 this had increased to 51.4 percent. The trend in Kent County was similar for all 3 years. This shows that a very large proportion of Kent and Washington Counties that was in farm land, cultivated, and had dwellings in 1880 has now gone back to forest land. Much of this is owned by large landowners who use it only as estates for summer homes and hunting preserves.

Table 3 shows a comparison of the acreage of the principal crops in 1879, 1929, and 1934 and the value of vegetables harvested for sale and of orchards and vineyards in 1879, as reported by the Federal census.

TABLE 3.—*Acreage of the principal crops grown in Kent and Washington Counties, R. I., in stated years*

Crops	Kent County			Washington County		
	1879	1929	1934	1879	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn, total	1,212	834	794	4,380	1,623	1,686
Harvested for grain	-------	145	90	-------	814	907
For other purposes	-------	689	704	-------	809	779
Oats threshed	435	2	1	2,347	79	60
Oats cut and fed unthreshed	-------	119	21	-------	289	204
Rye	300	4	7	318	18	6
Potatoes	765	175	304	1,144	420	1,114
All hay and forage	12,524	3,596	4,856	29,967	9,471	11,887
Alfalfa	-------	86	72	-------	76	341
Timothy and clover (alone and mixed)	-------	1,938	2,207	-------	3,488	6,859
Small grains cut for hay	-------	257	466	-------	221	662
Other tame and wild grasses	-------	1,272	2,089	-------	5,418	3,928
	Dollars			*Dollars*		
Vegetables harvested for sale	28,528	452	649	9,554	307	551
Strawberries	-------	27	30	-------	27	28
Orchards and vineyards	4,476	552	845	10,101	896	874

In 1880 Kent County had nearly 14 percent of its total area in cultivated crops. This decreased until in 1935 only a little over 6 percent of the total area of the county was producing cultivated farm crops. If orchards and all pasture land are included, this would leave about 80 percent of the county in forest, swamp, and city sites. More than three-fourths of the area surveyed is covered by forest, in most of which little or no attention is given to thinning out or establishing better stands. The land is cut over once in about 30 years for cordwood, and then nature is allowed to take its course in thinning out the new thick stand that comes in. Forest fires are destructive and have burned over considerable areas of the land surveyed. These facts indicate that better forestry practices are greatly needed.

The present agriculture consists of the production of corn for grain, meal, fodder, and silage; a small acreage of small grain; hay, principally timothy, Rhode Island bentgrass, and clover; potatoes and truck crops; orchard crops; and nursery stock. Market gardening and commercial flower culture have increased considerably in extent in recent years, especially near the larger cities. Pasture occupies a larger acreage than all the cultivated crops combined.

Table 4 gives the value of all farm products by classes in 1929 and the number and value of livestock and livestock products in 1930 for the two counties.

TABLE 4.—*Value of agricultural products by classes in Kent and Washington Counties, R. I., in 1929, and number and value of livestock in 1930*

Crop	Kent County	Washington County	Livestock and products	Kent County		Washington County	
	Dollars	*Dollars*		*Number*	*Dollars*	*Number*	*Dollars*
Cereals	5,974	45,087	Horses	404	37,992	679	84,973
Other grains and seeds	328	14,165	Mules	4	448	17	1,850
Hay and forage	124,091	202,869	Cattle	4,038	371,850	5,821	515,594
Vegetables (including all potatoes)	95,919	186,671	Swine	316	4,224	657	8,416
Fruits	47,150	54,063	Sheep	227	2,028	1,602	13,796
Farm garden vegetables for home use (excluding potatoes)	25,440	43,174	Chickens	50,778	68,550	72,581	97,984
			Butter, cream, and whole milk sold		517,848		615,094
			Wool		271		1,935
Trees, plants, flowers, seeds, bulbs, etc.	24,350	11,950		*Dozen*		*Dozen*	
Flowers and vegetables grown under glass	9,080	149,895	Chicken eggs produced	443,218	212,745	625,972	300,467
Forest products cut on farms, for home use and for sale	97,730	73,395	Total		1,215,956		1,640,109
			Total agricultural products		1,646,018		2,421,378
Total	430,062	781,269					

Corn occupies the largest acreage of cultivated crops. Most of the corn crop in Kent County is cut for silage, but in Washington County more is harvested for grain. The average acre yield is about 40 bushels of shelled corn or about 10 tons of silage. Corn is adapted to nearly all of the well-drained soils of the area, although the yield is much higher on the finer textured plains soils than on the coarse-textured soils or the stony upland soils. The main corn variety grown is Rhode Island Flint, much of which is used for making meal.

Sweet corn occupies a fairly large acreage near Providence in Kent County. Most of the sweet corn is a very good quality of Golden Bantam which yields about 600 dozen ears an acre. Sweet corn grows very well on the sandy Merrimac soils.

Potatoes are grown in all parts of the area, but especially on the finer textured plains soils near Slocum and on Narragansett loam near Ninigret Pond. With heavy fertilization, acre yields of 400 bushels are frequently obtained. Green Mountain and Irish Cobbler are the principal varieties grown. A number of potato growers in Washington County plant annually more than 100 acres each. On these farms the most up-to-date equipment is used. The crop is either marketed as dug or put in storage for later sale. On the farms where potato growing is of secondary importance the crop is usually sold locally or consumed at home. Fertilizing, spraying, and thorough cultivation are essential for large yields. Most of the larger producers plant potatoes year after year on the same land and apply heavy applications of fertilizers, a 4–8–10 [3] mixture being used most generally, although during the last few years a more concentrated mixture, 8–16–16, has become popular. Rye is used as a cover crop.

The principal market-garden crops are cabbage, cantaloups, asparagus, carrots, beans, and cauliflower. Yields are usually fairly high on the sandy soils. Both counties possess exceptional opportunities for the marketing of truck crops, as the excellent State roads enable the farmer to take or send his products to the consumer in a very short time, and the customers can easily visit the farmers' roadside markets. The town of Warwick produces the largest quantity of truck crops. Most of the truck crops are grown on Merrimac fine sandy loam.

Strawberries, as well as other small fruits, such as blueberries, raspberries, and blackberries, are grown successfully on the Narragansett and associated upland soils. More land could be devoted to growing these crops than is used at present, as the climate and many of the soils are particularly adapted to small fruits.

Nurseries and greenhouses are fairly profitable and are increasing in importance. The principal flowers grown are carnations, roses, snapdragons, chrysanthemums, pansies, and many potted plants. All kinds of trees, especially conifers, are grown in the nurseries.

Commercial fertilizers are used extensively on nearly all of the plains soils and on many of the upland soils. According to the 1930 Federal census, 68.2 percent of the Washington County farmers used commercial fertilizer in 1929, which had a total value of $58,101, or an average of $137.03 for each farm reporting its use. In Kent County, 51.6 percent of the farmers reported spending $51,582 for fertilizer, or an average of $168.56 a farm. Commercial mixed fertilizers are most commonly used. For truck crops about a ton an acre of 5–8–7 is applied and also about a ton of lime every 4 or 5 years. Manure is applied whenever available. For best results, fertilizer, manure, and lime are required. Cow manure seems best for truck crops during dry seasons and chicken manure during wet seasons.

[3] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

As reported by the 1935 census, hay is the most extensive crop grown, occupying 16,743 acres in 1934. It is fairly well distributed over the area surveyed. Charlestown, West Greenwich, and Coventry have the least hay acreage of any of the towns in the two counties. The average yield is slightly more than a ton an acre. About one-third of the acreage consists of timothy or timothy and clover mixed. The growing of Rhode Island bentgrass for seed is becoming more and more important. In 1929 Washington County had 252 acres producing 861 bushels of grass seed, not all, however, being Rhode Island bent.

Pasture, which includes woodland and other pasture, occupied 16,927 acres in Kent County and 31,910 acres in Washington County in 1934. The pasture land is widely distributed over the area. The best pasture and the highest percentage of the land in pasture are in the eastern third of the counties surveyed, especially on the Newport and Narragansett soils.

Most of the orchards have been established for some time and consist chiefly of apple trees; very few young orchards were noted during the survey. Most of the orchards are on the uplands. The town of Richmond has the largest number of trees in the area surveyed and Charlestown the least. The town of Warwick contains more commercial orchards than any other in the area surveyed, and it has a fairly large number of nonbearing trees that will come into production within a few years. Most of these trees are planted on the well-drained well-aerated Merrimac soils. The orchards in the town of Richmond are planted chiefly on the sloping Gloucester soils. In 1934 Kent County produced 9,556 bushels of apples from 23,939 bearing trees, and Washington County produced 5,534 bushels from 22,239 bearing trees. The chief summer varieties are Red Astrachan and Yellow Transparent; the fall varieties are McIntosh, Wealthy, and Gravenstein; and the principal winter varieties are Baldwin, Northern Spy, and Rhode Island Greening.

Peach orchards are scattered throughout the area surveyed and return an additional income to many farmers. Most of the orchards are small, and little attention is given to the care of the trees or to the selection of salable fruit.

Grapes, pears, plums, and cherries are grown locally to a very small extent. Wild grapes grow abundantly, especially on the sloping Newport soils; this would indicate that grapes could be grown satisfactorily in the eastern part, an especially well-adapted location being on either side of the Narrows on the sloping hillsides. The soils on the outwash plains are not so well adapted to fruit as the upland soils that have good air drainage and are not so subject to early and late frosts.

Hog raising has never been very important, and only a small proportion of the farmers raise hogs. The 1930 census reports 1,096 hogs in the two counties.

In 1934 Washington County had 687 horses and Kent County 450. The work horses are of good breeding, and few horses of the small bronco type are used on the farms. The saddle horses are well-bred and easy gaited, and some owners of large estates have exceptionally fine horses. Only a few colts are raised on the farms. Most of the horses are broken to work single, as many of the farm implements are small and require only one horse.

The raising of beef cattle and the raising of sheep were important farm interests in Rhode Island before railroads were built in the Central West.

About 1880, the forest growth in Rhode Island began to encroach on the farmed land, open pastures began to disappear, and with them went many flocks of sheep. In 1934 Washington County had 924 sheep, and Kent County had only 131, which is about one-fourth the number in 1850. The greatest distribution of sheep is in the towns of Richmond, Hopkinton, and Narragansett. Large areas of land that would make good sheep pasture are now idle, and it would seem that sheep raising might be extended in such areas.

Since 1860 the number of beef cattle has decreased and of dairy cattle has increased. In the early days the raising of many of the cattle for use as work oxen was an important source of farm income. Very few herds of beef cattle are now raised. The most important source of farm income from livestock during recent years has been dairying. A few excellent herds of Milking Shorthorns and many herds of purebred dairy cattle, such as Holstein-Friesian, Ayrshire, Guernsey, and Jersey, are in the two counties. The percentage of purebred dairy cattle is high, and Kent is a 100-percent accredited tuberculosis-free county. The distribution of dairy cows is such that the largest herds are concentrated either near cities or on the better soils, especially the good grass-producing soils such as the Newport, Narragansett, and the heavier textured Merrimac soils. Most dairies sell whole milk, chiefly to the wholesale milk dealers in the nearby industrial towns. Some cream, butter, and cheese are also sold, but these products have shown marked declines in recent years.

As dairying is the most extensive farm enterprise, considerable thought should be given to pasture improvement. The pastures undoubtedly could be greatly improved by fertilization, especially with phosphorus and nitrogen. On the average farm, one cow requires about 6 acres of pasture; however, most dairymen supplement the permanent pasture feed with barn feeding. Some soils are worth two or three times as much for pasture as others. The Newport and Narragansett soils are good for producing pasture, especially where the land is level, the Newport soils being the better of the two. The Newport soils are slightly less acid than either the Narragansett or the Gloucester soils. The pastures on the Newport soils contain a high proportion of Kentucky bluegrass, some Rhode Island bentgrass, and a little fescue. Many large estates are on this soil, and the land is better cared for than that in the western part of the two counties. Pastures on the Narragansett soils contain a high proportion of bentgrass, some Kentucky bluegrass, and some fescue. Of the three series, the Gloucester soils are the most acid, on the average the most coarse textured, and the poorest for pasture. On these soils the grass consists chiefly of fescue and bentgrass, with Kentucky bluegrass only in the more moist areas. The heavier textured Merrimac soils having imperfect drainage are well adapted to pasture, but the other Merrimac soils require more fertilizer to produce the same yield. Several good dairies are located on Merrimac very fine sandy loam and on Narragansett loam. These soils can be greatly improved by the addition of phosphate fertilizers also.

The raising of poultry is an important agricultural enterprise in Kent and Washington Counties. According to the 1930 census the value of poultry and poultry products nearly equaled the value of dairy products in Kent County and was about one-third the value of the dairy products in Washington County. About one-third of the total value of poultry and poultry products is represented by the birds themselves and the other two-thirds by their products. The area of greatest distribution of poultry is nearly identical with that of the greatest distribution of dairy cows, although poultry farms require different kinds of soil from those of dairy farms. The best poultry flocks are either on rolling well-drained land or on nearly level but very sandy excessively drained land. Some of the poorest agricultural soils in the area, such as Gloucester stony sandy loam and Merrimac loamy sand, make very satisfactory poultry yards. This is one branch of agriculture that can be carried on successfully in areas too stony for cultivation. Many large flocks of highly bred chickens, principally Rhode Island Red, White Leghorn, New Hampshire Red, and Plymouth Rock, are in the two counties. Several large turkey farms are in the area, but the number of turkeys is only about one-tenth of the number in 1890. The decrease is due largely to the difficulty of combating disease. The main breeds are Bronze, White Holland, and Narragansett. Ducks and geese have also decreased in numbers since 1890.

According to the 1930 census, the average size of the farms was 78.2 acres in Kent County and 140.1 in Washington County. On the averaged-size farm about 20 acres were in crops, 30 acres in pasture, and the remainder in woodland, building sites, and waste land. The 1935 census reports the average size of farms in Kent County as 68.4 acres and in Washington County as 104.9 acres. Since 1880 the number of acres in cropland and pasture has decreased, with a corresponding increase in forest land and waste land. The size of the farms has increased somewhat in recent years, especially in the upland, because of the consolidation of a number of idle farms into estates and into private hunting and fishing preserves. The average value of the land in the eastern and southern parts of the area is about $30 an acre, and in the western part it is less than $20 an acre. The 1935 census gives the average assessed acre value of land and buildings as $107.18 in Kent County and $70.30 in Washington County. This is somewhat misleading, as land near Providence in the northeastern part of Kent County sells for more than $500 an acre as suburban property, whereas in the western part of the county land can be bought for less than $10 an acre. The 1935 census reports the average value of land and buildings for each farm as $7,334 in Kent County and $7,378 in Washington County.

The farmers in the western two-thirds of the two counties spend very little for farm labor, on an average not more than $225 a year for each farm, as much of the labor is performed by members of the family. Near the industrial towns, many of the farmers work part of the time in the factories. In the eastern one-third the farms are larger, and on many estates the average expenditure for hired labor is $800 or more annually. Wages are much higher than in the South or Central West, day wages ranging from $3 to $5. Truck growers employ many boys and girls for light work.

Farm tenure has changed little since 1880 in Washington County, but in Kent County the percentage of farms operated by owners has increased considerably. In 1934, 86.2 percent of the farms in Kent County and 75.2 percent of those in Washington County were operated by owners and part owners; 1.6 percent in Kent County and 3.8 percent in Washington County by managers; and 12.2 percent in Kent County and 21 percent in Washington County by tenants.

The equipment of the farms ranges from the most modern equipment for growing potatoes to that of the small-crop farms using oxen. The farmers in Kent and Washington Counties are conservative with regard to farm machinery, buildings, and luxuries, and many of the farmers still use one-horse machinery to good advantage.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers or horizons called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil[4] and its content of lime and salts are determined by simple tests. The drainage, both internal and external, and other external features, such as the relief or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. Upon the basis of these characteristics soils are grouped into mapping units. The three principal ones are: (1) Series, (2) type, and (3) phase. Areas of land such as coastal beach or bare rocky mountain sides that have no true soil are called (4) miscellaneous land types.

The most important of these groups is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus Narragansett, Gloucester, and Merrimac are names of important soil series.

Within a soil series are one or more soil types, defined according to the texture of the upper portion of the soil. Thus the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt

[4] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Newport loam and Newport sandy loam are soil types within the Newport series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping and because of its specific character is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a subgroup of soils within the type, which differ from the type in some minor soil characteristic that may, nevertheless, have an important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be portions which are adapted to the use of machinery and the growth of cultivated crops and other portions which are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping portions of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils of Kent and Washington Counties do not differ essentially from soils in similar physiographic positions in Connecticut and Massachusetts. Much of the soil of the New England States is very stony and infertile compared to the soils of the prairies and plains in the Middle West. With application of fertilizers, crop production is fairly high on most of the soils, but the quantity of stones on many farms is so large that it is the limiting factor for crop use. The quantity of stones in most of the upland soils is sufficient to prohibit the use of large modern machinery, and one-horse cultivators, hayrakes, mowers, and wagons are in common use. This method of farming has had an important part in the decrease of the relative importance of agriculture in New England as compared to increases in other sections of the country. Although the texture and structure of much of the upland soils are conducive to good root penetration, water percolation, good drainage, and a high water-holding capacity, nevertheless, year after year, more of the farming land has grown up to forest. The combination of humid climate, favorable soil, and declining agriculture has made Rhode Island a forest region. Forests have always occupied the rougher, steeper, and stony land, but since about 1850, trees have gradually encroached on the better land until at present practically only the level land is in cultivated crops. These level areas include the best soil, are the easiest to till, are the more productive, and most of them have been

cleared of stones by past generations. Trees have also encroached on many of the stone-free plains soils that are sandy in texture, so that only the heavier and best plains soils are free from the invasion of forests. In time, because of shifting trends of agriculture, some of the land now reforesting may again be cultivated for truck crops and grass.

Twelve series of mineral soils, including 29 soil types and 17 phases, in addition to 4 miscellaneous land types, 1 organic soil type, and 2 organic soil phases, have been mapped.

The soil types have been arranged in groups having like characteristics and like agricultural usage, in order to show the relationship existing between certain groups of soils and their agricultural use and management. In this area the mineral soils have been arranged into three main groups based on physiography, drainage, and relief: (1) Well-drained soils of the uplands; (2) imperfectly drained soils of the uplands; and (3) soils of the outwash plains. In addition, a group of organic soils and a group of miscellaneous land types, practically all of which are nonagricultural, are described.

In the following pages of this publication the soils are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and table 5 gives their acreage and proportionate extent.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Kent and Washington Counties, R. I.*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Narragansett loam	5,568	1.7	Narragansett stony loam, imperfectly drained phase	1,344	0.4
Narragansett loam, rolling phase	1,920	.6	Bridgehampton silt loam	960	.3
Narragansett stony loam	14,592	4.6	Bridgehampton very fine sandy loam	4,672	1.5
Narragansett stony loam, level phase	16,896	5.3	Merrimac very fine sandy loam	2,752	.9
Narragansett stony fine sandy loam	5,440	1.7	Merrimac very fine sandy loam, rolling phase	768	.2
Narragansett stony fine sandy loam, level phase	7,168	2.2	Merrimac very fine sandy loam, imperfectly drained phase	1,920	.6
Narragansett stony fine sandy loam, rolling phase	3,968	1.2	Merrimac fine sandy loam	9,472	3.0
Narragansett gravelly fine sandy loam	896	.3	Merrimac fine sandy loam, shallow phase	5,632	1.8
Gloucester stony fine sandy loam	44,224	13.9	Merrimac fine sandy loam, rolling phase	768	.2
Gloucester stony fine sandy loam, level phase	20,928	6.6	Merrimac loamy sand	9,344	2.9
Gloucester stony very fine sandy loam	16,000	2.0	Merrimac loamy sand, imperfectly drained phase	1,344	.4
Gloucester stony very fine sandy loam, level phase	5,632	4.8	Merrimac gravelly coarse sandy loam	1,856	.6
Gloucester stony sandy loam	20,480	6.4	Warwick loamy sand	1,536	.5
Gloucester stony sandy loam, level phase	4,736	1.5	Warwick fine sandy loam	768	.2
Newport loam	1,664	.5	Warwick fine sandy loam, shallow phase	2,048	.6
Newport fine sandy loam	5,596	1.8	Carver loamy coarse sand	704	.2
Newport fine sandy loam, steep phase	2,084	.6	Carver loamy sand	2,304	.7
Newport sandy loam	1,664	.5	Muck and peat	11,648	3.6
Hinckley gravelly sandy loam	17,856	5.6	Muck, shallow phase	8,832	2.8
Hinckley gravelly sandy loam, dark-colored phase	1,600	.5	Peat, salt-marsh phase	960	.3
Hinckley loamy sand	7,296	2.3	Coastal beach	512	.2
Quonset sandy loam	2,112	.7	Dune sand	768	.2
Whitman silty clay loam	5,696	1.8	Tidal marsh	1,472	.5
Whitman loam	4,416	1.4	Rough stony land (Gloucester soil material)	13,376	4.2
Whitman stony loam	9,024	2.8			
Whitman fine sandy loam	1,280	.4	Total	319,360	
Mansfield silty clay loam	3,136	1.0			
Ninigret very fine sandy loam	960	.3			
Gloucester stony sandy loam, imperfectly drained phase	768	.2			

WELL-DRAINED SOILS OF THE UPLANDS

The well-drained soils of the uplands include soils of the Gloucester, Narragansett, Newport, Hinckley, and Quonset series. The Gloucester soils occur throughout New England on the glaciated uplands and are derived almost entirely from granite and other crystalline rock. The Newport and Narragansett soils were mapped for the first time in this area. The Narragansett soils differ from the Gloucester soils in having more firm or slightly compact grayer subsoils, darker surface soils, and less rough relief, and they are derived from finer grained rocks, such as granite gneiss and schists. The Newport soils are similar to the Narragansett soils, except that the former are derived from shale, sandstones, and conglomerates and have slightly less acid subsoils and a noticeable bluish-green cast in all layers.

In the 1904 soil survey report,[5] Newport and Narragansett soils were called Miami stony loam. The Miami soils are now confined to specific light-colored soils in Indiana, Ohio, and Michigan. In the former survey the Gloucester soils were all classified as Gloucester stony loam, but in this survey three soil types and four phases, all but one of the latter being in this group of well-drained upland soils, have been differentiated as members of the Gloucester series.

The more level areas of the Narragansett, Newport, and Gloucester soils are all used to a great extent for farm crops. The Newport soils are the most naturally productive, followed by the Narragansett and the Gloucester soils. The Newport soils have been influenced the least by glacial till, and the Gloucester soils have been the most strongly influenced by this material. The heavy-textured types in each series are more productive than the lighter textured types. The rolling areas of the Narragansett soils are better agriculturally than some of the level phases of the Gloucester soils, but they are not so easy to till as the level areas of the Narragansett soils. The level and rolling areas of each series are more productive than the hilly areas, which are more productive than the steep areas. The level and rolling areas are used mostly for crops and grass, and only the poorest portions are in forests. The rougher areas of the Newport, Narragansett, and Gloucester soils are used very little except for forestry. The heavier textured soils of the Gloucester and Narragansett series are about equal for tree production, but the Newport soils are slightly superior. The rougher and steeper the relief, however, the less valuable is the land for forestry.

The Hinckley soils are extensive throughout New England and New York. They are derived mostly from glacial drift consisting of granite gneiss and other crystalline rock material.

The Quonset soils constitute a new series established in Washington County. Some areas of Quonset sandy loam are near Quonset Point, from which this soil derives its name. This soil differs from the Hinckley soils in being derived mostly from shale and sandstone. It is slightly less acid and has dark-colored subsoil layers. Both the Hinckley and Quonset soils have a hummocky relief and are used mostly for forest.

See footnote 1, p. 1.

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Narragansett loam.—Almost the entire area of Narragansett loam has been cleared of trees, and a large proportion of it is cultivated (pl. 1, *A*). It is considered one of the best soils of the uplands for general farm crops. In a cultivated field the surface soil, to a depth of nearly 10 inches, is very dark grayish-brown loam that abruptly changes to pale yellowish-brown firm loam or very fine sandy loam. This usually rests on firm olive-colored very fine sandy loam, at a depth of about 20 inches, which, in turn, gradually changes to a brown friable fine sandy loam subsoil. At a depth below 4 feet the material consists of coarse sand, gravel, and a few rocks.

Both the surface soil and the subsoil are acid, although the material in areas near the coast is not so acid as that in areas several miles inland. The relief of this soil is nearly level. It is associated geographically with other Narragansett soils. The large area near Ninigret Pond resembles an outwash fan, whereas other areas resemble an outwash plain. This soil is probably influenced both by glacial till and outwash plains material. If bedrock is under this soil, it lies very deep. Narragansett loam is a productive soil, and in some places potatoes, with heavy fertilization, yield more than 350 bushels an acre. Corn yields about 60 bushels an acre, and other crops accordingly. Several large uncultivated areas of this soil are producing a good growth of grass.

This soil is well drained, and, as it has a deep fairly heavy subsoil, it has a high water-holding capacity. It responds to heavy applications of fertilizer and is easily tilled. Most of the areas are sufficiently large for the use of modern machinery. Land composed of this soil currently sells for about $60 an acre.

Narragansett loam, rolling phase.—Areas of Narragansett loam that have rolling or nearly hummocky relief are mapped as a rolling phase of Narragansett loam. The soil of this phase is productive, but because of its unfavorable relief it is not used to a great extent for cultivated farm crops, most of it being in grass and orchards. Erosion would be an important factor if this land were cultivated, especially on the steeper and more rolling parts. It should be a good soil for fruit trees, as it has good surface and subsoil drainage and is favorably situated for good air drainage. The soil material is deep and of good quality, and it is free or nearly free from surface stones. In places the lower subsoil contains some stratified sand and gravel. This soil is similar to the rolling phases of the Merrimac soils.

This soil is not very extensive. It is associated with the typical soil in the vicinities of Congdon Hill and Mooresfield and in a few other places.

Narragansett stony loam.—Narragansett stony loam is one of the extensive well-drained upland soils in the eastern part of the area. It is characterized by a yellowish-brown to dark-brown shallow loam surface soil, underlain by a pale yellowish-brown friable loam subsoil that grades into an olive-colored firm heavy loam layer, at a depth of about 15 inches, which restricts the downward movement of water. This heavy material continues to a great depth but contains more coarse material with depth.

Drainage is not so good as on the Gloucester soils, and during the spring months many wet seepage areas are noticeable even on

sloping hillsides. Undoubtedly the percolating water reaches the olive-colored heavy layer and then flows laterally to some natural outlet. Both the surface soil and subsoil are acid. In most places this soil contains numerous stones and boulders, limiting its use to pasture and forest, to both of which it is well adapted. The principal trees are oak, locust, elm, and chestnut. The relief ranges from smoothly sloping hillsides to steep slopes, although over most areas the slopes are moderate.

Narragansett stony loam, level phase.—Areas of Narragansett stony loam, level phase, are easily differentiated from the typical soil by the relief and the smaller stone content. Most of this land is in cultivated crops. It is the most extensive of the Narragansett soils and occurs in fairly large areas over the eastern and southern parts, the largest areas occurring in the vicinities of Kingston and East Greenwich, on Point Judith Neck, and along the coast as far west as Winnapaug Pond.

The surface soil, when wet, is very dark brown medium-plastic loam about 8 inches thick, underlain by pale-yellow medium-plastic loam that rests on a somewhat compact gray very fine sandy loam layer at a depth ranging from 18 to 24 inches. This layer restricts the downward percolation of water and the penetration of roots. It is locally called a hardpan, but it does not have the hardness or chemical characteristics of a true hardpan. When crushed between the fingers it readily breaks into fine grains, but in place it is firm and slightly cemented. Below this layer is a gray glacial till composed of a mixture of fine sandy loam, very fine sandy loam, and silt. Both the surface soil and the subsoil are acid and may contain stones and boulders. This soil, like the other Narragansett soils, is formed from fine-grained granitic materials which have influenced the texture of both the surface soil and the subsoil.

This soil is considered by farmers as a good agricultural soil, but it requires fertilizer to produce profitable yields of such crops as corn, clover, and potatoes. Grass grows exceptionally well even if the soil is neglected for a short time. This soil, where neglected for several years, produces a thick stand of brush, shrubs, and trees. It produces profitable yields of berries, as both soil and climate are favorable for such crops. Strawberries are grown to a fairly large extent on this soil and when carefully managed and fertilized produce high yields, ranging from fifty 32-quart crates an acre in dry years to 200 crates in the most favorable seasons.

Narragansett stony fine sandy loam.—Narragansett stony fine sandy loam occurs in small scattered bodies throughout the area on sloping or steep relief. It differs from Narragansett stony loam in having a coarser, sandier texture in all layers and is less productive. It is usually associated with the sandy-textured Gloucester soils and occupies the lower parts of the slopes. It is used almost entirely for the production of timber, which is about equally divided between hardwoods and softwoods.

Narragansett stony fine sandy loam, level phase.—Areas of Narragansett stony fine sandy loam that have a smooth or nearly level relief are mapped as a level phase. Fairly large uniform bodies of this soil are distributed over the entire area, the largest being west of Wickford, in the northwestern corner of Kent County, and in the

northwestern corner of Washington County. It is derived from slightly coarser textured rocks than Narragansett stony loam.

Agriculturally, soil of the level phase is much superior to the typical soil, as a large proportion of it is tilled or in pasture, whereas a very small proportion of the typical soil is either cultivated or regularly pastured. It is not so productive as either Narragansett loam or Narragansett stony loam, level phase. Because of the level relief, this soil has a deep and well-developed surface soil and subsoil, which have not been affected by sheet erosion and have had a better chance to become more productive than the soil on slightly rolling slopes that are eroded. This soil, with the exception of a few areas, contains fewer stones than the typical soil because the occupants of the land have gathered them from year to year and built stone walls. Gravelly and stony areas of this soil are used for pasture only, as the stones are so numerous as to preclude the removal of them all. Some of the most stony areas are in the southern part of Washington County.

Narragansett stony fine sandy loam, rolling phase.—In the southern part of Washington County, in what seems to be a position beyond the terminal moraine, are fairly extensive areas of rolling land, which have been mapped as a rolling phase of Narragansett stony fine sandy loam.

This soil differs from both the Hinckley soils and the other Narragansett soils but has some characteristics of both. The surface soil consists of a 6-inch layer of grayish-brown light loam or fine sandy loam, underlain by yellowish-brown very fine sandy loam or fine sandy loam. This rests on olive-gray silty very fine sandy loam at a depth ranging from 14 to 18 inches. Below this material are stratified layers of sand and gravel like those in the Hinckley and Merrimac soils. All the soil material is acid. Considerable numbers of rounded boulders are scattered over the surface and throughout the soil, but this soil is not so stony as Narragansett stony loam. It is well drained, and the gray layer is not so compact as in the typical Narragansett soil.

The soil varies considerably from place to place and is not so uniform as the other Narragansett soils. In places the surface soil is dark grayish brown and in others light brown. The depth to gravel ranges from 20 inches to 4 feet. The relief ranges from rolling to hilly and in places hummocky with many rounded pockets or sinks and some water holes.

Only a small proportion of this soil is cultivated. Yields of oats, corn, clover, and grass are fairly high but not so high as on the level phase of this soil type. Most of this soil is in grass or is idle and growing up to bayberries and wild raspberries. Areas of this soil 3 or more miles inland produce very good timber.

Narragansett gravelly fine sandy loam.—Narragansett gravelly fine sandy loam occupies small-sized areas of undulating or level relief in the vicinities of Ninigret Pond and other ponds along the Atlantic coast. It differs from Narragansett loam in having a gravelly fine sandy loam texture and is less productive. Nearly the entire area is in cultivated crops or good pasture.

Gloucester stony fine sandy loam.—Gloucester stony fine sandy loam, which occupies nearly 14 percent of the total area of the two

counties, is the most extensive soil. It occurs throughout all the area west of the Narragansett Basin.

The surface soil is brownish-gray, yellowish-brown, or brown friable fine sandy loam ranging from 3 to 6 inches in thickness. The subsoil is light-brown or rich-brown loose friable fine sandy loam, which grades into a gray or dark-gray friable sandy loam lower subsoil layer that becomes coarse in texture with depth and rests on bedrock at an average depth of 10 feet. In places, only a thin surface layer of soil covers the solid rock below. Such areas usually are on the steep hillsides associated with rough stony land or rock ledges. In many places numerous stones and boulders are scattered over the surface, and the subsoil is a mass of rocks and rock fragments.

Most of this soil occupies rough broken relief which is hilly and almost mountainous in character. Drainage ranges from good to excessive. The parent material is in part residual and in part glacial in origin and bears a distinct relation to the underlying medium-grained granite or other crystalline rocks.

This land is used almost entirely for the production of cordwood from the fair to good stands of oak, ironwood, and pine. The diameter of a 30-year-old oak is between 8 and 10 inches. Black, red, and white oaks seem to grow equally well. When cut the trees yield about 20 cords an acre. A 30-year-old pine growing in this soil ranges from about 12 to 14 inches in diameter.

Gloucester stony fine sandy loam, level phase.—Gloucester stony fine sandy loam, level phase, is the second most productive Gloucester soil in the area. It is inferior in crop production to the heavier textured Gloucester stony very fine sandy loam, level phase, but because of its coarser texture it is more easily tilled and requires less skill in handling to maintain good tilth.

It is characterized by a brown or grayish-brown loose friable fine sandy loam surface soil that, when tilled, works into a good seedbed. The subsoil is yellow-brown fine sandy loam slightly more sandy and more friable than the surface soil. It is underlain, at a depth ranging from 15 to 20 inches, by gray friable till containing numerous boulders and large gravel, which extends to bedrock at an average depth of about 12 feet.

About 70 percent of this soil is in cultivated crops and grass, and the rest is in forest consisting mostly of white, red, and black oaks. This soil occurs throughout all areas of glacial till derived from crystalline rocks, practically all of which is outside the Narragansett Basin.

Gloucester stony very fine sandy loam.—Gloucester stony very fine sandy loam is one of the least extensive of the Gloucester soils and lies chiefly on the sloping to steep glacial hills. It is derived from fine-grained granitic material and is associated with Narragansett stony loam. It differs from the Narragansett soil in having a lighter colored surface soil, a richer brown subsoil, and less compaction in the lower subsoil layer. It is used in the same way as Narragansett stony loam and produces just as good timber, but it is not so productive for pasture.

Gloucester stony very fine sandy loam, level phase.—Gloucester stony very fine sandy loam, level phase, is the most productive and

most desirable of the Gloucester soils in Rhode Island. It is characterized by a brown friable easily tilled very fine sandy loam surface soil, underlain by a yellow friable subsoil of nearly the same texture. This rests on gray friable fine sandy loam, at a depth ranging from 20 to 24 inches, which continues to an average depth of 12 feet to bedrock, becoming more loose and gravelly with depth.

This soil is acid in all layers and needs some lime for the production of clover. When fertilized it produces from 40 to 45 bushels of corn an acre and about 35 bushels of oats. Potatoes do very well, but yields are not so large as on the heavier Merrimac soils or on the Bridgehampton soils. Probably more than 80 percent of this soil is cultivated or in grass. It is the most productive soil for grass of the Gloucester series but is not naturally so good as either the Narragansett or the Newport soils. This soil is heavy enough in all layers to have a high water-holding capacity and a fairly high amount of plant nutrients, yet it allows roots to penetrate freely and water to percolate to low depths. This soil erodes very little, and it dries quickly and can be cultivated soon after a rain. In most areas the surface stones have been removed, and cultivation is less hindered than on any other Gloucester soil.

This soil is derived from slightly finer textured rock material than the other Gloucester soils, therefore it more nearly approaches the Narragansett soils than the other Gloucester soils. In mapping, the boundary lines between Gloucester stony very fine sandy loam, level phase, and Narragansett stony loam, level phase, in many places are arbitrary. Gloucester stony very fine sandy loam, level phase, is associated with the Narragansett soils and lies along the eastern edge of the Gloucester soil region.

Gloucester stony sandy loam.—Gloucester stony sandy loam is the poorest of the Gloucester soils. It is derived from a coarse-grained granite and is excessively drained. Under virgin forest it usually is characterized by a surface layer, an inch or two thick, of leaf mulch, underlain by a nearly white strongly acid layer of mineral soil, ranging from 2 to 4 inches in thickness. This rests on a 6- or 8-inch layer of rich-brown or coffee-colored sandy loam which gradually changes to slate-gray sand and gravel. In most places the surface soil and the subsoil consist of a mass of rock fragments and fine earth. Bedrock is usually much deeper under this soil than under the other Gloucester soils, particularly on the terminal moraine in the southern part of Washington County. The terminal moraine consists of a poorer quality of material than the average Gloucester soil. In such areas the soil is very similar to Plymouth sandy loam as mapped in eastern Massachusetts and on Long Island, but in Kent and Washington Counties the difference from the Gloucester soil is so slight that the soil is included with the Gloucester soils.

The areas of Gloucester stony sandy loam are generally hilly and so stony that they are used almost entirely for forest, the trees grown being mostly pitch pine, white pine, and some oak and chestnut. Most of this soil is in the western part of Washington County in fairly uniform large tracts.

Gloucester stony sandy loam, level phase.—The level phase of Gloucester stony sandy loam is more productive than the typical soil

but is less productive than the level phases of the other Gloucester soils. It is characterized by a rich-brown or brown loose friable sandy loam surface soil, underlain by a pale yellowish-brown friable loamy sand subsoil, which gradually merges into gray coarse sand, gravel, and rocks.

This soil, being more sandy, is less fertile and more droughty than the other members of the Gloucester series. About half of it is cultivated to corn, clover, and orchards, and the remainder is in pasture or forest. The trees are mostly white pine and pitch pine. This soil is on the flatter hilltops associated with the typical soil, chiefly in the western part.

Newport loam.—Newport loam is an inextensive soil on slopes in the eastern part of the area, the largest bodies being northeast of Wakefield.

It is characterized by a grayish-brown loam surface soil having a greenish-blue tinge and by a yellowish-brown friable loam upper subsoil layer that rests on a greenish-gray or olive-green fine sandy loam lower subsoil layer. This soil is acid in all layers but not so acid as the Narragansett or Gloucester soils, especially in the subsoil. Flat rocks are scattered over the surface and through the subsoil.

This soil occupies rather steep slopes adjacent to the streams and is used almost entirely for pasture and forest (pl. 1, *B*.). A few old orchards are growing on the soil but no large commercial orchards. The land is well adapted to both forest and fruit trees, as well as to grass, berries, and grapes.

This soil is derived to a considerable extent from glacial till, but it shows the influence of the underlying finer grained blue shale.

Newport fine sandy loam.—Newport fine sandy loam is the most extensive soil of the Newport series. It lies on level or nearly level broad hilltops from the northeastern boundary of the area surveyed south to Wakefield. In a cultivated field it is easily distinguished from the associated Narragansett or Gloucester soils by its unusual greenish-blue cast.

It is characterized by an easily tilled dark slate-colored fine sandy loam acid surface soil and a less acid brown or greenish-olive friable subsoil. This soil is well drained but may show signs of excessive moisture during the spring.

Most of this soil is cleared of stones and is used for cultivated crops. In productivity, it is slightly inferior to Newport loam but is superior to Narragansett stony fine sandy loam. The stone walls on this and the associated Newport soils are built of flat stones in contrast to the large rounded stones in the walls on the Narragansett and Gloucester soils.

Newport fine sandy loam, steep phase.—Bodies of Newport fine sandy loam, steep phase, occur only in the Narragansett Basin division and are confined to slopes and steep hillsides. This soil is used for forest, and a small acreage of the best land is in pasture. It differs from Newport loam in having a sandier textured surface soil and a slightly looser sandier subsoil. It seems to be as good for forest as is Newport loam or Narragansett stony loam. It is not so stony as the typical Narragansett soils, and many of the stones are flat.

Newport sandy loam.—Newport sandy loam is an inextensive soil occurring on Warwick Neck in Kent County and near Belleville in

Washington County. It is associated with Newport fine sandy loam and is similar in all characteristics except texture. In some respects this soil is very similar to Warwick fine sandy loam but it lies on the upland and contains some stones and rock outcrops, although the stones are not so numerous as on the other Newport soils.

Newport sandy loam occupies nearly level relief and is nearly all in general farm crops or grass. Several large estates are on this soil, and, usually, such land is not tilled but is used for pasture.

Hinckley gravelly sandy loam.—Hinckley gravelly sandy loam is confined to the areas of stratified sand and gravel deposits in the form of hummocky hills, kames, eskers, and rough slopes on outwash plains and terraces.

In most places the surface soil, to a depth of 4 or 5 inches, is loose friable light-brown gravelly sandy loam, which gradually changes to rich yellowish-brown gravelly sandy loam that rests on stratified beds of gray coarse sand and gravel. These deposits range from 15 to more than 100 feet in depth. Unless heavily limed, all layers of this soil are acid. In some areas stones are strewn over the surface, but other areas are stone free. The stones do not interfere seriously with agricultural use. The material in this soil is almost entirely from granite gneiss and other crystalline rocks. On account of the relief and the open friable structure of the surface soil and the subsoil, this soil is excessively drained, and crops suffer in times of drought.

About two-thirds of this soil is cleared and used for pasture, which is mediocre in years of normal rainfall, nearly valueless in dry years, and fair in wet years. It is better adapted to pasture than to field crops. Several areas have been heavily limed and planted to clover or alfalfa, both of which do surprisingly well on such droughty soil. Forested areas produce a poor stand of white pine, a thick stand of pitch pine, and little or no underbrush.

Practically all areas of Hinckley gravelly sandy loam include pockets or depressions, ranging from 30 feet in diameter to several acres. The soil in these depressions is much superior to that on the hills for grass, field crops, and truck crops. It consists of fine sandy loam which is uniform in color, texture, and structure to a depth of more than 2 feet. Such areas are so inaccessible that very little attempt is made to utilize them differently from the adjacent hills. These depressions apparently consist of the finer material washed from the hills.

The gravel in this soil is used extensively in concrete work and for road surfacing. The soil is more valuable for road-building material than for agriculture. In Rhode Island, because of the large quantity available, gravel does not sell for so high a price as in localities where it is scarce.

This soil occurs throughout nearly all the area, usually near streams. In places it occupies fairly large areas, and in other places it is represented by small local deposits. Usually, the larger the stream the larger the area of Hinckley gravelly sandy loam.

Hinckley gravelly sandy loam, dark-colored phase.—Areas of hummocky land lying near the southern coast in Washington County and having a much darker colored surface soil than the typical soil, are mapped as Hinckley gravelly sandy loam, dark-colored phase.

Soil of this phase differs from the typical soil in being associated with glacial till soils, such as Narragansett gravelly fine sandy loam, Narragansett stony fine sandy loam, rolling phase, and Gloucester stony fine sandy loam, rather than with the plains soils, such as the Merrimac and the Carver soils. Soil of this phase probably has a slightly higher proportion of fine material and less coarse sand than the typical soil. Its dark-colored surface soil indicates a higher content of organic matter, and it is therefore slightly better for pasture. Nearly the entire acreage is used for pasture, with the exception of areas used as banks for obtaining sand and gravel. Some stones and boulders are scattered over the surface and throughout the subsoil.

The vegetation on this soil consists of buckthorn, redtop, bentgrass, and some timothy.

Hinckley loamy sand.—Hinckley loamy sand occurs on kame and kettle topography closely associated with the sandy textured plains soils, but it is very easily differentiated from them because of its hummocky relief. In places the boundary between this soil and Hinckley gravelly sandy loam, with which it merges, is arbitrary. This soil contains little gravel throughout the soil mass. It is acid and ranges from loamy sand to sandy loam from the surface to a depth below 30 feet. The poorest areas of this soil approach typical sand-hill country, and the land is of low agricultural value. It is less used for crops and pasture than the other Hinckley soils. and more than half of it is forested with pitch pine and white pine, the pitch pine predominating. In some areas it is nearly barren and subject to some wind erosion, as in the area about 2½ miles southeast of Westerly, the area a mile north of Sauga Point, and the area near Pojac Point.

Quonset sandy loam.—Quonset sandy loam is confined to areas of hummocky stratified gravelly and sandy hills in sections where the Newport soils are dominant. The principal difference between this soil and Hinckley gravelly sandy loam is that a large proportion of the material below a depth of 15 inches is bluish-green gravel which is less acid than corresponding layers in the Hinckley soil. This soil is mostly derived from shale and conglomerates and to less extent from granite. It has been formed similarly to the Hinckley soils, but the material from which it was derived was transported by glaciers from shale and conglomerate material rather than from granitic material.

Farmers consider this a better soil agriculturally than any of the Hinckley soils. It contains a slightly higher proportion of fine-grained material in all layers, especially in the subsoil, and it is less acid than the Hinckley soils. In places, especially near East Greenwich, sweetclover grows wild along roads and on waste land. This soil is nearly all cleared. On some farms on this soil, corn and potatoes are grown to a small extent, but the acre yields are somewhat lower than those on the poorer grades of Merrimac soil. Pasture is recommended as the best land use for this soil.

IMPERFECTLY DRAINED SOILS OF THE UPLANDS

The imperfectly drained soils of the uplands include those soils of the glaciated uplands that, because of their topographic position or

of some characteristic of the soil, have either surface drainage or subsurface drainage, or both, restricted to such an extent as to influence crop production or land utilization. This group includes the Whitman, Mansfield, and Ninigret soils and the imperfectly drained phases of Gloucester stony sandy loam and Narragansett stony loam.

The Whitman and Mansfield soils are the wettest soils in this group and may have water at or near the surface for several months during the year. They occur as swamps along streams, around springs, and near drainageways. Their gray or bluish-gray subsoils show lack of aeration. These soils, unless drained, are used only for pasture or forest and the stone-free areas for hay, a larger acreage being used for forest than for pasture. These soils are extensive throughout the glaciated sections of the New England States. The Whitman soils are associated with the Gloucester soils in granitic areas, and the Mansfield soils are associated with the Newport soils in shale or sandstone areas.

Ninigret very fine sandy loam is a member of a new series mapped for the first time in Washington County near Ninigret Pond. As this soil has a nearly black stone-free surface soil and is less acid and more poorly drained than Narragansett loam, the soil it most resembles, it is mapped separately and given a new series name rather than being designated as a phase of Narragansett loam. This soil, in the former soil survey, was included with Warwick sandy loam. It is used chiefly for crop production, especially hay.

The imperfectly drained phases of Gloucester stony sandy loam and Narragansett stony loam, as their names imply, are areas of these two soils that have restricted drainage. Crop adaptations are slightly different from those on the typical soils. These two soil phases are used mostly for crop production, especially for hay. These soil are much better than the Whitman or Mansfield soils, but they do not rate with the best soils of the area surveyed.

Whitman silty clay loam.—Whitman silty clay loam, in its usually wet condition, is characterized by a dark-gray or almost black medium-plastic silty clay loam surface soil, grading into a mottled gray, light-gray, yellow, and rust-tinged plastic silty clay subsoil which continues to a depth below 3 feet. The surface soil and subsoil are acid and may contain stones and boulders.

This soil occurs in flat and depressed narrow strips bordering small streams where drainage is imperfectly established or as basin-shaped areas at the heads of drainageways. It is formed mostly from glacial till and is developed where conditions are favorable for the accumulation of organic matter but not in sufficient quantities to form muck. In many places the soil lies between muck areas and the adjacent uplands. It occurs throughout areas of the Gloucester and Narragansett soils, especially in the heavy-textured types.

This soil is used almost entirely for forest and pasture. The principal trees are swamp maple and birch. Where drained, this soil is very desirable for pasture, except during long dry periods, which are rare in Rhode Island.

Whitman loam.—Whitman loam is characterized by a very dark grayish-brown or black loam or silt loam surface soil 8 or 10 inches thick, underlain by a gray or yellowish-gray slightly heavier subsoil

that becomes less heavy with depth. Both surface soil and subsoil are medium plastic when wet but hard and brittle when dry.

This soil occupies small areas along some of the larger streams. It is formed from glacial till and to some extent from glacial lake and river terrace material, and a small portion of the material consists of wash from the adjacent upland. It contains very few boulders or stones on the surface and not nearly so many in the subsoil as the other Whitman soils.

Nearly the entire area of this soil has been cleared of trees and is used for the production of wild hay and cranberries and for pasture. Wild hay yields about 2 tons an acre. Most of the cranberries are not well cared for, and the yields are low. This is the most valuable of the Whitman soils. It occurs throughout areas occupied by the Gloucester and Narragansett soils. In the former soil survey of Rhode Island this kind of land was classed as meadow. In places this soil has a sandy subsoil, but the sand does not seem to affect its productivity.

Whitman stony loam.—Whitman stony loam is the poorest soil of the Whitman series. It is used entirely for forest, producing mostly maple and birch and some hemlock.

This soil consists of a black loam or silt loam surface soil, to a depth of 8 or 10 inches, underlain by nearly white material ranging from fine sand to silt loam. Both the surface soil and the subsoil contain very many stones and boulders. This soil usually has water at or near the surface most of the year. Trees grow surprisingly well in view of the small amount of soil material as compared to the large proportion of boulders and stones over the surface and through the soil mass. This soil occurs throughout the western two-thirds of the two counties and is nonagricultural.

Whitman fine sandy loam.—Whitman fine sandy loam is the most inextensive of the Whitman soils in the two counties. It consists of a dark-gray or nearly black fine sandy loam surface soil and a nearly white fine sand or fine sandy loam subsoil which continues to a depth of more than 3 feet. The entire soil is very acid. Both the surface soil and the subsoil contain large quantities of stones and boulders.

The relief, like that of the other Whitman soils, is flat, and the soil occupies narrow strips bordering small streams that traverse the sandier types of the plains soils in the western part of the area. This soil is formed mostly from glacial lake and river terrace material, and it is developed where the lack of drainage favors the accumulation of organic matter, resulting in a much darker color than that of the adjacent sandy types of the plains soils. It is of less value for crops than the plains soils because it is wet most of the time and warms late in the spring. It is used mostly for the production of trees for cordwood, principally maple, some pine, and a few cedar trees. If cleared and drained it would be productive pasture land, and if the stones were removed it would be fairly productive for crops, although it is more subject to frost than the higher land. The cost of clearing the land for crops, however, would be very great.

Mansfield silty clay loam.—Mansfield silty clay loam is the poorly drained upland soil associated with the Newport soils. It has a

dark-gray or black silty clay loam surface soil, usually with a covering of a few inches of mucklike material. The surface soil is usually wet and plastic, but when dry it cracks and becomes hard. The subsoil is dark gray with some mottling of yellowish-brown and bluish-green slightly compact silty clay. In places the bluish-green color is very noticeable. This soil is slightly less acid than Whitman silty clay loam, the soil it most closely resembles. In many places some stones and angular rock fragments are scattered on the surface and throughout the soil mass. The soil is formed from the weathered products of glacial till derived mostly from shales and sandstones and some material from conglomerates and crystalline rocks.

This soil is on level to gently sloping relief, usually occupying long narrow flat or depressed areas adjacent to drainageways in the eastern part of Kent and Washington Counties. The natural drainage is poor, and the soil is waterlogged during most of the year. It is used very little for cultivated crops. It is more productive for grass than the stony Whitman soils, and drained areas make very good pastures. The tree growth is slightly more dense than on the Whitman soils, and the shrub growth is heavier. This soil bears the same relation to the Newport soils of the shale region as the Whitman soils do to the Gloucester soils of the granite region.

Ninigret very fine sandy loam.—Ninigret very fine sandy loam is an imperfectly drained nearly level soil occurring mostly near the southern seacoast associated with Narragansett loam.

This soil is nearly all cultivated, and in the cultivated fields it is easily recognized by its nearly black color. The surface soil is very fine sandy loam that works readily into a good tilth and allows roots to penetrate easily and deeply and water to percolate freely. The upper part of the subsoil is pale yellowish-brown heavy very fine sandy loam, which gradually changes to a mottled gray, light-yellow, and rust-brown very fine sandy loam lower subsoil layer. Gravel and some stones are present at a depth below 6 feet. The surface soil is free from stones, and neither the surface soil nor the subsoil is so acid as the corresponding layer of the Narragansett or Gloucester soils.

This soil is mostly developed from weathered fine-grained granitic gneiss. It occupies nearly level to gently sloping relief. The natural drainage is not so good as on Narragansett loam, but crop production is benefited to some extent by the imperfect drainage. Corn and oat yields are slightly higher on this soil than on Narragansett loam, but potato yields are somewhat lower. Nearly all of this soil is in crops, except near streams, where it gradually merges with the Whitman soils. Such areas support a cover of brush and grass.

Gloucester stony sandy loam, imperfectly drained phase.—Level areas of Gloucester stony sandy loam that have impeded drainage are mapped as an imperfectly drained phase. This soil has a nearly black loose friable sandy loam surface soil underlain by a yellowish-brown or brown slightly heavier subsoil which gradually changes to firm but not compact slate-gray sandy loam. This is underlain by a mixture of fine sand, silt, gravel, and boulders. This soil is developed from material weathered from granitic till on nearly level or slightly depressed areas. Because of the relief, drainage is so

restricted that the surface soil is darker than that of the typical soil.

Small bodies of this soil are in the southwestern part of the area, principally in the vicinity of Hopkinton. In a few places the soil occupies bottom or terracelike positions adjacent to streams, where it has better drainage than the bottom land. About one-half of this soil is used for cultivated crops, and the rest is in pasture and meadow. Comparatively few boulders are on the surface, but some are in the subsoil. During dry years, soil of this phase is more productive than the typical soil. Hay yields about 1¾ tons an acre, corn about 45 bushels of grain or 12 tons of silage, and potatoes, of which few are grown, about 200 bushels.

Narragansett stony loam, imperfectly drained phase.—Narragansett stony loam, imperfectly drained phase, has some of the characteristics of both Narragansett stony loam, level phase, and Whitman silty clay loam. The surface soil is similar to that of the level phase of Narragansett stony loam, and the lower part of the subsoil is similar to the subsoil of Whitman silty clay loam.

This soil consists of a brown or dark-brown loam or silt loam surface soil, ranging from 6 to 9 inches in thickness, which is somewhat plastic when wet and medium hard when dry. The subsoil, to a depth of about 14 inches, is brown or yellowish-brown silt loam, and below this, to a depth of about 24 inches, it is mottled yellowish-brown and gray silt loam. The substratum is dark-gray or white firm and somewhat cemented silt loam which is usually wet. Both the surface soil and the subsoil contain a few boulders.

The relief is nearly level or slightly depressed, as the soil occurs on broad level hilltops associated with typical Narragansett stony loam. The soil of this phase, like the other Narragansett soils, is derived from weathered granitic gneiss and schists.

Nearly 80 percent of this soil is cleared and used for grass, pasture, and to some extent for crops. The soil is not so good agriculturally as Narragansett stony loam, level phase, the soil it most closely resembles. The soil of the imperfectly drained phase should be very good for berries, shrubs, and some flowers. It is well adapted for pasture, as grass grows abundantly and has a fairly high nutritive value. Because of its somewhat heavy texture it is hard to till and should be plowed or cultivated only at the optimum moisture content; for this reason, most of it is used for hay or pasture. The area north of Kingston, which has been neglected for the last few years, is now covered with a very dense growth of valueless brush.

SOILS OF THE OUTWASH PLAINS

The soils on the outwash plains include soils of the Bridgehampton, Merrimac, Warwick, and Carver series. With the exception of a few areas of Merrimac soils near streams and swamps, these soils are all well to excessively drained. The soil in areas where drainage is restricted have been mapped as imperfectly drained phases. All areas are nearly level, except those occupied by soils designated as rolling phases. Shallow phases have been mapped in areas in which gravel is closer to the surface than normal, which naturally affects agricultural practices and production.

The Bridgehampton, Merrimac, and Carver are old-established series. The Bridgehampton soils are especially important in the potato-growing section of Long Island on level outwash plains. The Merrimac soils occur throughout New England on the more coarse-textured glacial outwash plain areas. Some of these soils make excellent truck-crop land. The Carver soils also occur throughout New England on the most droughty outwash plains where the materials are chiefly quartz sand.

The name Warwick was given to nearly all of the sandy soils on the plains in the former soil survey of Rhode Island, but in this publication the name Warwick refers to the soils of only a very small proportion of the sandy plains, mostly in the vicinity of Warwick, that have bluish-green subsoils.

In a comparison of the value of the soils of these four soil series for several farm crops, the Bridgehampton soils head the list, followed by the Warwick, Merrimac, and Carver soils in the order named. The heavy-textured soils, as a rule, rate higher than the more sandy soils, and on this basis Merrimac very fine sandy loam would be more valuable than Warwick fine sandy loam, but, because of other characteristics, Warwick fine sandy loam is better agriculturally than Merrimac very fine sandy loam. The shallow phases of the different soils are much less productive than the typical soils. The rolling phases may or may not be so productive as the shallow phases, but, because of their unfavorable relief, these rolling soils are not used for farm crops nearly so much as are the shallow phases.

Bridgehampton silt loam.—Bridgehampton silt loam, although not very extensive, is the best agricultural soil in the area. Nearly 100 percent of it is cultivated, largely to potatoes, which yield, year after year, from 300 to 400 bushels an acre when properly cared for and heavily fertilized.

This soil, in a cultivated field, has a very dark grayish-brown friable silt loam surface soil, 9 or 10 inches thick, underlain by a pale yellowish-brown friable loose very fine sandy loam or silt loam subsoil. This rests, at a depth of about 20 inches, on olive-gray silty very fine sandy loam that abruptly changes to rich yellowish-brown very fine sandy loam at an average depth of 36 inches. Below this layer is stratified sand and gravel. This soil has been formed as an outwash plain in quiet water, mostly from material from nearby fine-grained granite gneiss and other fine-grained crystalline rocks.

This soil is acid in all layers, but it is well drained, free from stones, easily cultivated, and has a high water-holding capacity. Its relief is nearly level, and it occupies areas sufficiently large to allow the use of modern machinery. It responds to large quantities of fertilizers. Weeds are not numerous on this soil, and soil erosion is not a serious problem, except in a few places where other soils have been washed in from slopes. All farm crops are productive on this soil, which yields more than other soils year after year. More care is required during cultivation to establish good tilth than on some of the lighter textured soils. The largest areas of this soil are near Slocum and West Kingston, and small areas are in other places.

Bridgehampton very fine sandy loam.—Bridgehampton very fine sandy loam, like Bridgehampton silt loam, is a general all-round good soil. It is not especially adapted to any particular crop but

is well adapted to nearly all crops grown in this section of New England. It is well drained, is well aerated, has an easily tilled deep surface soil, and has a medium-high water-holding capacity. All these qualities, combined with its smooth rock-free surface soil and nearly level relief, make possible the use of modern machinery for nearly all farm crops. It responds favorably to fertilizers and intensive farming. Most of the plots of the Rhode Island Agricultural Experiment Station are on this soil. High yields have been obtained from nearly all farm and truck crops, as reported in the experiment station bulletins. Very favorable results have also been obtained with grass for lawns and golf greens, with shrubs, with berries, and with some nursery stock.

The essential difference between this soil and Bridgehampton silt loam is that this soil has a slightly lighter colored lighter textured surface soil and has stratified gravel and sand nearer the surface. Areas in which the gravel is within 3 feet of the surface are mapped as Merrimac very fine sandy loam.

Bridgehampton very fine sandy loam lies on the nearly level plains in the vicinities of Usquepaugh, West Kingston, and Slocum. Some fairly large areas of this soil are idle and have grown up to brush, but the field indications are that this land is distinctly arable and, so far as quality of soil and relief are concerned, could well be cultivated, as it is one of the best soils in Rhode Island. The expense of clearing wooded land is about $300 an acre if the trees or stumps are large.

Merrimac very fine sandy loam.—Merrimac very fine sandy loam is the most productive Merrimac soil in the area. The surface soil in a cultivated field ranges from brown to dark grayish-brown mellow very fine sandy loam about 6 inches thick. The subsoil is yellowish-brown or pale yellowish-brown friable very fine sandy loam that gradually changes to rich yellowish-brown fine sandy loam just above stratified sand and gravel, which occur at a depth of about 30 inches. All layers of this soil are acid, and lime is essential for the production of a good stand of clover or alfalfa.

This soil occupies smooth or nearly level relief and is associated with other plains soils throughout the area. It is used extensively for all general farm crops, producing nearly as large yields as Bridgehampton very fine sandy loam, but, as gravel is nearer the surface, crops suffer more during a long protracted drought on this soil than on the Bridgehampton soils. Yields of all deep-rooted crops average lower on this soil than on the Bridgehampton soils, but shallow-rooted truck crops yield as well. This soil responds favorably to the application of fertilizers, manures, and lime. Most of it covers large enough tracts to allow the use of modern machinery, although many areas are handled in a less efficient way. Many areas of this soil now in trees or brush would be very productive in cultivated crops. A few ice-block holes occur in places, but most of these have been mapped with the rolling phase of this type. In some small areas this soil has the characteristic gray very fine sandy loam layer above the gravel that is characteristic of the Bridgehampton soils.

Merrimac very fine sandy loam, rolling phase.—Areas of Merrimac very fine sandy loam that have an uneven or rolling relief are

mapped as a rolling phase. The soil in these areas is very inferior to the typical soil for the production of cultivated crops, as the surface soil is shallower, partly because of erosion and partly because of less soil development, and gravel is usually nearer the surface, causing the soil to dry out more quickly during drought. The unevenness of the surface is a disadvantage in cultivation. A large proportion of this soil, especially the rougher parts, is in grass, but the better areas are used for corn, potatoes, and fruit trees.

This soil is scattered throughout the plains soils area in small tracts ranging from 20 to 80 acres each, although a few tracts are more than 100 acres in extent. In some places soil of this phase includes the slopes of the typical soil.

Merrimac very fine sandy loam, imperfectly drained phase.—Areas of Merrimac very fine sandy loam in which the water table is at a depth of less than 3 feet during parts of the year are mapped as an imperfectly drained phase. Soil of this phase differs from the typical soil in having a slightly darker surface soil and either gray or rust-colored stains in the subsoil, indicating lack of aeration. This soil differs considerably from place to place. Some areas are included in which gravel lies at a depth of 2 feet, and other areas have a fine sandy loam surface soil. The soil variations included in this phase are small in extent, and agriculturally, they are all very similar.

Merrimac fine sandy loam.—Merrimac fine sandy loam is the most extensive soil of the outwash plains. The northeastern part of Kent County is covered by a large outwash plain consisting mostly of this soil, which is typical of the Merrimac soils. Merrimac fine sandy loam is similar in all characteristics, except texture, to Merrimac very fine sandy loam. It has a slightly lower moisture-holding capacity and is more loose and friable, which is reflected in slightly lower yields especially during dry seasons.

About 70 percent of this soil is cleared and used for cultivated crops. This land is more widely used for truck crops (pl. 1, *C*) than any other soil in the two counties. Crop production is fairly high, especially where the land is well fertilized and irrigated. On a well-managed truck farm, acre yields average 600 bushels of tomatoes, 1,000 dozen ears of sweet corn, 3,000 dozen carrots, 300 bushel boxes of cabbage, 600 boxes of peppers, 300 bushels of pod beans, 400 boxes of cantaloups, 800 boxes of cauliflower, 1,200 boxes of spinach, and 1,000 boxes of lettuce. The fertilizer most commonly used is about 2,000 pounds of a 5–8–7 mixture an acre yearly and about a ton of lime every fourth year. On the large area of this soil in the northeastern part of Kent County, land prices are so high, because of desirable sites for residential subdivision, that many of the truck growers will have to reestablish farms elsewhere on cheaper land. Some of the land here sells for $500 or more an acre, although this same soil in more remote districts can be bought for less than $50 an acre.

Some of this soil contains, on the surface and in the subsoil, considerable gravel, which is a disadvantage in cultivation, but farmers report that production is as good as on the gravel-free soil. About 80 percent of the gravelly areas are producing truck crops, and other areas are in dwelling sites or forest.

Merrimac fine sandy loam, shallow phase.—Areas of Merrimac fine sandy loam in which gravel beds occur within 12 or 18 inches of the surface are mapped as a shallow phase, but in other characteristics the soil is similar to the typical soil. The shallow phase, because of the slight depth at which gravel occurs, is much more leached of its plant nutrients and naturally is affected by drought of even short duration. Farmers consider this soil of low quality, and very little of it is in cultivated crops. About half of it is in pasture, and the other half is in forest, mostly of pitch pine and white pine. The better parts of this soil, where it is associated with better types of the plains soils, can be used advantageously for truck crops, such as carrots.

Merrimac fine sandy loam, rolling phase.—The rolling phase of Merrimac fine sandy loam bears the same relation to the typical soil as the rolling phase of Merrimac very fine sandy loam does to its typical soil. The rolling phases of the two soils differ in surface texture, and the rolling phase of Merrimac fine sandy loam is the poorer of the two. In characteristics it approaches the hummocky Hinckley gravelly sandy loam and is used almost entirely for pasture and for forests, to both of which it is fairly well suited. The largest area is about 1½ miles northeast of Slocum.

Merrimac loamy sand.—Merrimac loamy sand is the predominant plains soil associated with coarse-textured Gloucester soils. It is fairly extensive, but, agriculturally, it is of little importance.

This soil is essentially the same as the other Merrimac soils, except that it is coarser textured and is loose and incoherent throughout. It contains little or no gravel to a depth below 3 feet, and in places below that depth are layers of coarse sand intermixed with fine sand. Over fairly large areas this soil is uniformly a loose yellowish-brown loamy sand to a depth below 4 feet. It occupies broad level terraces.

Because of the loose open structure of the surface soil and the subsoil, drainage is excessive, and water passes rapidly through to lower depths. This soil is easily leached of fertilizer or lime, and manure is a more permanent source of plant nutrients than commercial fertilizers.

A very small proportion of this soil is in cultivation, and most of it supports a scant growth of pitch pine, scrub oak, and some white pine. The area near Charlestown is nearly all in grass, but most of the area near Wood River Junction supports a cover of pitch pine. Abandoned fields soon grow up to nearly valueless brush, berries, and pine. A larger proportion of this soil is waste land than of any other soil type of the well-drained Merrimac or Warwick soils, with the exception of Merrimac gravelly coarse sandy loam.

Merrimac loamy sand is very droughty, and crop yields are low except in wet seasons. It is very doubtful that this soil will become important for truck crops, although it does not contain gravel at a slight depth, but the looseness of the sand tends to make it unproductive and subject to drought. With irrigation and heavy applications of fertilizer, it should produce satisfactory yields of truck crops when the seasons are of sufficient length to prevent frost damage, a factor in areas where this soil occurs. The heavier textured Merrimac soils can be used for truck crops or other cultivated crops to better advantage than Merrimac loamy sand.

Merrimac loamy sand, imperfectly drained phase.—Areas of Merrimac loamy sand that show evidence of sufficient amounts of water near enough to the surface to affect the agricultural value of the land are mapped as an imperfectly drained phase. This phase is characterized by its dark-brown friable shallow surface soil, underlain by a yellowish-brown loamy sand subsoil that has streaks of gray or rust brown in the lower part. The substratum is gray fine sand intermixed with coarse sand and in places with gravel. This soil is used only for forest.

Merrimac gravelly coarse sandy loam.—Merrimac gravelly coarse sandy loam is the poorest soil of the Merrimac series, and, agriculturally, it is less valuable than Carver loamy sand. It is chiefly between Worden's Pond and the western boundary of Washington County.

The soil is characterized by a yellowish-brown gravelly coarse sandy loam incoherent surface soil about 6 inches thick, underlain by a yellow gravelly loamy sand subsoil, which rests on stratified coarse sand and gravel at a depth ranging from 14 to 20 inches.

This soil is excessively drained and supports a cover of forest trees, mainly pitch pine with some scrub oak, which grow slowly and are of poor quality, although the vegetation in some places consists of a thin stand of poor quality grass. Reindeer moss is usually abundant. Areas near streams or where the water table is within a few feet of the surface are more desirable and more productive for tree growth.

Warwick loamy sand.—Warwick loamy sand is the most extensive of the nearly level, deep, smooth soils on the outwash plains containing material from the shales, sandstones, and conglomerates of the Narragansett Basin region. It occupies broad smooth plains on Potowomut Neck and in that general vicinity.

The surface soil of Warwick loamy sand consists of brown heavy loamy sand that, when cultivated, is loose, mellow, and easily penetrated by roots. The subsoil is friable fine sand predominantly yellow but containing many flat slate-colored small pebbles. Below this layer, at a depth of about 30 inches, is an olive-green sandy loam layer less acid than the surface soil and, in places, even neutral in reaction. It is firm in place, as the fine-grained material seems to have some cementing action on the larger particles. This material continues to a great depth, becoming more coarse textured with depth.

The soil includes some variations from place to place, especially as regards the olive-green layer which, although everywhere in evidence, in places may be very near the surface and in other places is not very distinct, even in the lower part of the subsoil.

Agriculturally this soil is better than Merrimac loamy sand, the soil it most closely resembles, but it is not so productive as the heavier textured Warwick and Merrimac soils. About 50 percent of Warwick loamy sand supports a forest cover consisting of white pine, some pitch pine, oak, and brush; about 45 percent is in grass, of which some is used for pasture and some remains idle; and only about 5 percent is in cultivated crops, chiefly truck crops and corn.

Warwick fine sandy loam.—The surface soil of Warwick fine sandy loam is essentially the same as that of Merrimac fine sandy loam, but the subsoil consists of considerable quantities of black pebbles and bluish-green fine sandy loam that grades into dark-colored stratified sand and gravel at a depth of about 30 inches.

This soil lies along the level plains of Narragansett Bay and is derived to a considerable extent from material of the Narragansett Basin region, which consists chiefly of shale and sandstones with some conglomerates. This soil is, agriculturally, as good as, if not better than, Merrimac fine sandy loam. This is the least extensive of the Warwick soils.

Warwick fine sandy loam, shallow phase.—The shallow phase of Warwick fine sandy loam bears the same relation to the typical soil as the shallow phase of Merrimac fine sandy loam does to its typical soil. The shallow phases of these two soils are similar in agricultural productiveness, but because of its proximity to the ocean, the salt breezes from which hinder tree growth, the shallow phase of the Warwick soil supports a larger proportion of grass than forest. This soil contains more dark-colored material in the subsoil than does the shallow phase of Merrimac fine sandy loam, and gravel occurs at an average depth of about 18 inches. The shallow phase of Warwick fine sandy loam is slightly less acid than the shallow phase of Merrimac fine sandy loam. It is associated with typical Warwick fine sandy loam.

Carver loamy coarse sand.—Carver loamy coarse sand is the poorest soil of the outwash plains and in many places is barren of vegetation. The surface soil consists of light-gray loamy coarse sand with large quantities of small gravel scattered over the top. This gravel also occurs throughout the subsoil which is light yellowish-brown coarse loamy sand that rests on fine sand or gravel at a depth ranging from 24 to 30 inches. This soil is derived chiefly from quartz.

Carver loamy coarse sand is associated with Hinckley loamy sand and occupies level areas chiefly in the vicinity of Woodville in the southwestern part of the area. Areas that are not barren support a sparse growth of pitch pine, birch, and brush. Few stones are on this soil. The relief is nearly level, and the barren areas are subject to wind erosion.

Carver loamy sand.—Carver loamy sand is the predominant soil of the sand plain north of Charlestown. Although fairly extensive in this section, where it is associated with the terminal moraine soils, it is of little agricultural importance. It is considered one of the least fertile soils of the two counties and supports a forest growth consisting almost entirely of pitch pine with a few white pine and birch trees.

This soil closely resembles Merrimac loamy sand but consists chiefly of quartz grains with little or no feldspar. It is more easily leached and is poorer agriculturally than Merrimac loamy sand. The shallow surface soil consists of yellowish-brown loose loamy sand. It is underlain by a lighter brown friable loamy sand subsoil that continues to a depth of several feet with but little change in texture or other physical characteristics. A few stones from 1 to 2 feet in diameter are scattered over the surface and throughout the soil mass.

ORGANIC SOILS

The group of organic soils comprises those soils having a high content of decomposed and partly decomposed plant remains. It includes the organic soils of the glacial-till plains, the outwash plains,

and the tidal marshes. Muck and peat; muck, shallow phase; and peat, salt-marsh phase, are the organic soils of this area.

Muck and peat.—Muck and peat are composed of plant remains that have accumulated in former ponds and depressions and along the borders of sluggish streams. As mapped, muck and peat include deposits of organic matter that is mostly in a raw or a partly decayed condition. The deposits are more than 3 feet deep and, with but few exceptions, are associated with fresh water. Muck and peat areas are rather extensive, especially in Washington County, and are usually associated with shallow ponds and swamps.

Muck and peat differ considerably from place to place in depth, degree of decomposition, character of material, and vegetation. Only one small area on the western side of Indian Cedar Swamp has been drained sufficiently to allow cultivation, and it is being planted to truck crops which should be fairly productive if not damaged by frost.

Muck and peat in the areas bordering inland streams and in the swamp areas consist of brown or black slimy surface material with a high proportion of leaf litter and partly decayed wood. Below this layer the material is reddish-brown partly decomposed organic matter which is light in weight, spongelike, and saturated with water and which continues to a depth below 3 feet, in places being more than 15 feet in depth. These areas are free from stones.

Red cedar grows well on the areas of deep muck and peat, but on the shallower parts the trees, although numerous, grow very slowly. Most of the muck and peat land at present supports a good growth of cedar, although a few areas have grown up to maple. Cranberries grow in the open areas, and in some of the wettest parts, where water stands most of the year, water-loving plants form the only vegetation. Some areas become dry during the summer, although water is usually within 3 feet of the surface. All muck and peat areas examined are strongly acid throughout the soil mass.

Muck, shallow phase.—Areas of shallow muck differ from typical muck in having mineral soil below an average depth of 20 inches. The surface soil is black waxy or fibrous well-decomposed material with but little evidence of the original leaf litter. This grades into a darker well-decomposed lightweight organic layer which rests on a gray mineral soil that ranges in texture from fine sand to silty clay and continues to a depth of more than 4 feet. In places the mineral soil is nearly white. Both the organic and the mineral soil layers are strongly acid. This soil is nonagricultural and supports a forest growth consisting largely of maple and alder. Some cranberry bogs in the less shaded areas were observed on this soil.

Around the margins of some of the swamps adjacent to level sandy soils of the plains, shallow muck and peat overlie a coffee-brown iron-cemented layer, from 2 to 5 inches thick, which rests on stratified white sand and heavier materials.

Peat, salt-marsh phase.—The salt-marsh phase of peat differs from other muck and peat in being composed of a coarse stringy reedlike material. It is grayish brown from the surface to a depth greater than 4 feet and seems to be rather uniform in color and texture throughout all areas of its occurrence. The largest areas border the tide-water basin north of Narragansett Pier, and other areas are

in sheltered spots along the harbors and coves of the eastern shore of the two counties. Little use is made of the salt-marsh phase of peat, and most of it is covered by saltgrass and some eelgrass. Agriculturally it is of about the same importance as tidal marsh. It is saturated with water most of the time.

MISCELLANEOUS LAND TYPES

Miscellaneous land types include those sand areas adjacent to the sea that are affected by the waves and wind, areas of tidal marsh, and areas of rough stony land. The sandy areas include coastal beach and dune sand, neither of which is extensive. They are nonagricultural, producing only a sparse growth of tall grass. In the former survey, both of these materials were mapped as Galveston fine sand. Tidal marsh occurs in quiet bays and on areas inland from the coastal beach sand. It produces a thick nearly valueless grass. Most of the rough stony land is in the western one-fourth of the two counties and is nonagricultural.

Coastal beach.—Coastal beach consists of the narrow level sandy fringe, ranging from a few feet to several rods in width, along the shore line, where the material has been deposited by wave action. Most of the silt and clay has been removed, and the remaining sand has been assorted to some extent by the waves. Near the water's edge, fair-sized cobbles and gravel are dominant in many places, but farther back the material is finer in texture and is not at present subject to the wave action. Organic matter has accumulated on that portion which supports a grass cover, but the land is low in fertility and produces only a scant vegetation. Most of it lies between the areas of dune sand and tidal marsh. It is used mostly for building sites and makes a smooth beach, which, for recreation purposes, commands a higher price than much of the good tillable land.

Dune sand.—Dune sand as mapped in Rhode Island consists of the reworked sand along the beaches that has been shaped by wind into ridges and dunes and that is bare or supports only a sparse cover of tall grass. The sand material is of recent deposition and is still subject to frequent change during severe storms. The sand consists mostly of well-rounded white quartz grains, stained locally by iron or magnetite.

Dune sand occurs as a long narrow fringe or ridge adjacent to the sea from beyond Watch Hill to Point Judith. Together with the adjacent coastal beach, it impounds many salt-water ponds. The sand contains some salt deposited by the ocean spray. Most of this land is valuable for summer-cottage sites along the coast. Cottages line nearly all the coast line, whereas in 1901 very few houses were along the coast.

Typical dune conditions exist in a few places in the interior of the two counties, but these areas have been mapped with Hinckley loamy sand.

Tidal marsh.—Tidal marsh includes those areas from Watch Hill to Point Judith, adjacent to and inland from the beach sand, that are subject to regular tidal inundation. These areas consist of shallow tidal flats which are exposed to the air during low tide and are just awash during high tide.

The surface 6-inch layer consists of a brown fibrous mat of sedge and grass roots having some sand grains mixed throughout. Below this layer is dark-gray sand fairly compact in place but very loose when excavated. This layer gradually changes to coarse gray loose incoherent sand at a depth below 30 inches. During low tide, water is within a foot of the surface.

Sedges or eelgrass grow on the submerged areas and saltgrass on the less saturated areas, all the vegetation being thick and tall. The tidal marsh areas are not continuous but are cut by narrow winding channels that lead to the numerous salt-water ponds. Drainage is lacking and can be accomplished in most places only by diking to exclude the salt water.

Tidal marsh is the result of the mingling of the coastal beach sand washed or blown over the tidal flats and mixed with finer sediments from the ponds and the subsequent growth and partial decay of the saltgrasses which form the present cover. When cut, this grass produces a coarse hay that is in little demand. This land has a firm subsoil, and when sand is pumped on it from the nearby bays, it makes desirable building sites. At present much of it affords only breeding areas for mosquitoes.

Rough stony land (Gloucester soil material).—Rough stony land (Gloucester soil material) is a land type rather than a soil. It includes areas which are exceptionally rough, stony, or shallow and are totally unfit for cultivation. Such small pockets of soil as do occur are chiefly Gloucester and Narragansett soil material. Some areas of this land are narrow and extend across the country for a distance of one-eighth mile or more, and other areas are essentially masses of large boulders. A few areas are nearly level, but rocks are so numerous and large that the land is unfit for cultivation and cannot be reclaimed at any reasonable cost.

This land is chiefly in the western part. It is used entirely for forest, but the stand of trees is generally thin, although in the better areas the growth is fairly rapid. The dominant trees are hemlock, oak, pine, and chestnut.

LAND USES AND AGRICULTURAL METHODS

Field observations show that most of the farmers are using their lands for the crops to which they are best adapted, especially on the uplands; but fairly large areas of apparently good, productive, level land on the outwash plains are idle and growing up rapidly to scrub oak and brush. This condition exists especially on large areas of Merrimac soil and also on a few areas of Narragansett loam, which probably could be used advantageously for growing crops, but, if many years elapse before attempts are made to cultivate these areas, the cost of clearing the land of trees and stumps will be considerable. As more than 80 percent of the area surveyed is in forest, it seems that more attention should be given to forestry. This is especially essential in planning for the proper kinds of trees to be grown on the different types of soil. From field observation it would seem that nature has been allowed to take care of nearly all of the forest land in the area. Too little attention has been given by the individual owners to fire prevention and to insect and disease control on the wooded land. Energy expended in improving the forest land should be

nearly as profitable as labor spent in clearing fields of stones for planting farm crops.

Such crops as raspberries, blackberries, strawberries, and blueberries probably could be cultivated more extensively than they are at present, to good advantage.

The relief, or lay of the land, is important in determining the ease with which farm machinery may be used, the susceptibility of the land to erosion when cultivated, and its suitability for production of crops, grasses, or trees. Susceptibility of the land to erosion, as well as the amount of erosion which has already taken place on lands which are or have been cultivated, is closely correlated with the degree of slope.

A grouping has been made of the soil types, phases, and miscellaneous land types in this area, on the basis of their characteristic degree of slope and the amount of sheet and gully erosion which has taken place on them. The degree of erosion, measured by the approximate percentage of surface soil removed, is, of course, reflected in the productivity of the land. Table 6 represents this grouping.

TABLE 6.—*Relations between soil types, slope, and erosion for the soils and land types of Kent and Washington Counties, R. I.*

Soil type, soil phase, or land type	Slope[1]	Sheet[2] erosion	Gully[3] erosion	Soil type, soil phase, or land type	Slope[1]	Sheet[2] erosion	Gully[3] erosion
Bridgehampton silt loam	A	0	0	Merrimac loamy sand, imperfectly drained phase	A	0	0
Bridgehampton very fine sandy loam	A	0	0	Merrimac loamy sand	A	0	0
Narragansett loam	A	0	0	Newport fine sandy loam, steep phase	D	2	1
Ninigret very fine sandy loam	A	0	0	Narragansett stony loam	D	2	1
Newport loam	A	0	0	Narragansett stony fine sandy loam	D	2	1
Narragansett stony loam, level phase	A	0	0	Narragansett gravelly fine sandy loam	B	2	1
Newport fine sandy loam	A	1	0	Gloucester stony very fine sandy loam	D	2	1
Gloucester stony very fine sandy loam, level phase	A	1	0	Gloucester stony fine sandy loam	D	2	1
Merrimac very fine sandy loam	A	0	0	Gloucester stony sandy loam	D	3	1
Narragansett stony fine sandy loam, level phase	A	1	0	Merrimac fine sandy loam, rolling phase	C	3	1
Warwick fine sandy loam	A	0	0	Quonset sandy loam	B	2	1
Merrimac fine sandy loam	A	0	0	Hinckley gravelly sandy loam, dark-colored phase	C	3	1
Gloucester stony fine sandy loam, level phase	A	1	0	Carver loamy sand	A	0	1
Newport sandy loam	A	1	0	Hinckley gravelly sandy loam	C	2	1
Gloucester stony sandy loam, imperfectly drained phase	A	0	0	Hinckley loamy sand	C	2	1
Narragansett stony loam, imperfectly drained phase	A	0	0	Whitman loam	A	0	0
Narragansett loam, rolling phase	B	2	1	Whitman fine sandy loam	A	0	0
Gloucester stony sandy loam, level phase	A	1	0	Whitman silty clay loam	A	0	0
Warwick fine sandy loam, shallow phase	A	0	0	Mansfield silty clay loam	A	0	0
Merrimac fine sandy loam, shallow phase	A	0	0	Peat, salt-marsh phase	A	0	0
Warwick loamy sand	A	0	0	Muck and peat	A	0	0
Merrimac very fine sandy loam, rolling phase	B	2	1	Muck, shallow phase	A	0	0
Merrimac very fine sandy loam, imperfectly drained phase	A	0	0	Tidal marsh	A	0	0
Narragansett stony fine sandy loam, rolling phase	B	2	1	Merrimac gravelly coarse sandy loam	A	0	0
				Carver loamy coarse sand	A	2	1
				Coastal beach	A	0	0
				Whitman stony loam	A	0	0
				Rough stony land (Gloucester soil material)	A	0	0
					D	2	1
				Dune sand	C	2	1

[1] Degree of slope: A, 0–5 percent, nearly level; B, 5–10 percent, rolling; C, 10–20 percent, hummocky; D, 20 percent and over, steep.

[2] Degree of sheet erosion: 0, none discernible; 1, 0–10 percent of surface soil gone; 2, 10–30 percent of surface soil gone; 3, 30–60 percent of surface soil gone.

[3] Degree of gully erosion: 0, none noticeable; 1, a few shallow gullies.

The lands that are nearly level and on which there is a minimum of erosion under normal conditions of tillage and usage are designated in table 6 by the symbol A. This includes lands with a maximum slope of 5 percent. The second class, B, includes most of the lands designated as rolling and includes that range of slope from 5 to 10 percent, on which erosion is a problem on the areas in clean cultivation under normal conditions but in which effective control measures can be maintained, especially on the best soils. The third class, C, includes those lands having a slope on which cultivated crops should not be grown frequently, but which can be used for pasture or, possibly, for hay. The steepest parts of these slopes are too steep to allow practical and economical erosion control for cultivated crops. This class includes slopes from 10 to 20 percent. The fourth class, D, includes all those lands having slopes too steep for effective control of erosion under most conditions and precludes their use for cultivated crops. They are used mostly for forest and pasture. This class includes slopes of more than 20 percent.

Erosion is of two main types—sheet erosion and gully erosion. The average degree of accelerated erosion which has taken place is shown in table 6 by index figures. Four degrees of sheet erosion and two of gully erosion are indicated in the table. Class 0 in each division indicates little or no erosion. Under the heading "Sheet erosion", class 1 indicates moderate sheet erosion, class 2 indicates a somewhat more advanced stage, and class 3 indicates severe sheet erosion in which much of the surface soil has been removed. Under the heading "Gully erosion", class 1 indicates the presence of a few shallow gullies or washes, which interfere somewhat with cultivation of the land.

Much information on the growing and management of different crops can be found in bulletins published by the Rhode Island State College Agricultural Experiment Station. The subjects treated include crops, fertilizers, crop rotations, varieties, and market gardening. These bulletins are mailed free on request.

RATING OF SOIL TYPES, PHASES, AND LAND TYPES ACCORDING TO PRODUCTIVITY

Table 7 gives a rating of the soil types, phases, and miscellaneous land types, according to productivity, for the more important crops grown in Kent and Washington Counties.

TABLE 7.—*Classification of the soils and land types according to productivity, for each of the important crops grown in Kent and Washington Counties, R. I.*

Soil type, phase, or land type	Crop productivity index [1] for—									Principal crops or type of farming
	Corn (grain)	Corn (silage)	Oats	Hay (except alfalfa) [2]	Alfalfa	Potatoes	Vegetables [2]	Tree fruits [2]	Pasture	
Bridgehampton silt loam	50 (90)	50 (90)	50 (60)	70 (95)	(70)	80 (170)	50 (90)	80	80	Potatoes.
Bridgehampton very fine sandy loam	50 (80)	50 (80)	50 (60)	70 (90)	(50)	75 (150)	40 (100)	80	70	Potatoes, vegetables, and pasture.
Narragansett loam	50 (80)	50 (90)	50 (60)	80 (100)	(70)	70 (165)	50 (90)	80	90	Do.
Ninigret very fine sandy loam	60 (80)	60 (80)	40 (60)	90 (110)	35 (60)	80 (120)	40 (70)	----------	90	Corn, hay, and pasture.
Newport loam	60 (80)	60 (80)	50 (60)	80 (100)	35 (55)	80 (140)	40 (90)	80	90	General farming.
Narragansett stony loam, level phase	30 (70)	40 (80)	50 (80)	60 (85)	(25)	50 (100)	20 (40)	70	80	Do.
Newport fine sandy loam	30 (60)	30 (60)	30 (60)	60 (80)	(35)	40 (90)	30 (60)	70	90	Do.
Gloucester stony very fine sandy loam, level phase	20 (50)	30 (50)	30 (50)	60 (75)	(30)	40 (100)	30 (40)	60	80	Do.
Merrimac very fine sandy loam	30 (60)	40 (70)	30 (50)	40 (70)	(45)	50 (120)	40 (60)	50	50	Potatoes, vegetables, and corn.
Narragansett stony fine sandy loam, level phase	30 (50)	30 (50)	20 (40)	50 (70)	----------	40 (50)	40 (60)	40	70	General farming.
Warwick fine sandy loam	30 (50)	30 (60)	30 (50)	30 (60)	25 (40)	40 (70)	40 (80)	70	60	Vegetables and potatoes.
Merrimac fine sandy loam	20 (40)	20 (50)	30 (50)	30 (50)	(35)	40 (60)	40 (80)	70	50	Do.
Gloucester stony fine sandy loam, level phase	20 (40)	30 (40)	20 (40)	40 (60)	----------	40 (50)	50 (70)	50	60	General farming.
Newport sandy loam	20 (30)	20 (30)	20 (30)	50 (75)	10 (45)	30 (50)	50 (70)	70	70	Do.
Gloucester stony sandy loam, imperfectly drained phase.	20 (75)	30 (75)	----------	60 (70)	----------	----------	----------	----------	80	Do.
Narragansett stony loam, imperfectly drained phase	30 (40)	30 (50)	----------	90 (100)	----------	----------	----------	40	80	Hay and pasture.
Narragansett loam, rolling phase	----------	----------	30 (50)	50 (70)	----------	----------	----------	70	70	Do.
Gloucester stony sandy loam, level phase	10 (30)	10 (30)	10 (30)	30 (40)	----------	30 (45)	30 (40)	40	30	General farming.
Warwick fine sandy loam, shallow phase	10 (30)	10 (30)	----------	30 (50)	----------	20 (45)	30 (40)	50	20	Do.
Merrimac fine sandy loam, shallow phase	10 (30)	10 (30)	----------	30 (40)	----------	20 (45)	30 (40)	50	20	Vegetables and corn.
Warwick loamy sand	10 (20)	10 (20)	----------	20 (30)	----------	20 (30)	20 (30)	40	10	Do.
Merrimac very fine sandy loam, rolling phase	----------	----------	----------	30 (50)	----------	----------	----------	60	50	Hay and pasture.
Merrimac very fine sandy loam, imperfectly drained phase.	----------	----------	----------	50 (70)	----------	----------	----------	----------	80	Do.
Merrimac loamy sand, imperfectly drained phase	----------	----------	----------	40 (60)	----------	----------	----------	----------	60	Do.
Narragansett stony fine sandy loam, rolling phase	20 (30)	20 (30)	20 (30)	30 (40)	----------	----------	----------	60	60	Pasture and hay.
Merrimac loamy sand	10 (20)	10 (20)	----------	20 (30)	----------	----------	20 (30)	30	10	General farming.
Newport fine sandy loam, steep phase	----------	----------	----------	30	----------	----------	----------	40	50	Pasture and forest.

[1] Soil types of significant acreage inherently most productive in the United States for the specified crop are given the index 100. Unusually productive soils of limited acreage may rate above 100. Figures in parentheses indicate the productivity according to current practices, which include the use of soil amendments, such as lime and fertilizers.

[2] In the case of such items as tame grass and hay, leguminous hay, vegetables, and tree fruits, each of which includes a group of associated crops, the index indicates the productivity of the soil for that member of the group best adapted to the soil in question. Thus, soil types well adapted to apples may be expected to have a high index for tree fruits, although their suitability for peaches or other fruits may be poor. In Kent and Washington Counties, hay (except alfalfa) includes bentgrasses, fescues, and clover and timothy; vegetables include those not requiring a highly organic soil, such as carrots, cabbage, melons, and tomatoes; apples are the principal criteria used for tree fruits.

TABLE 7.—*Classification of the soils and land types according to productivity, for each of the important crops grown in Kent and Washington Counties, R. I.*—Continued

Soil type, phase, or land type	Crop productivity index for—									Principal crops or type of farming
	Corn (grain)	Corn (silage)	Oats	Hay (except alfalfa)	Alfalfa	Potatoes	Vegetables	Tree fruits	Pasture	
Narragansett stony loam				20				50	50	Pasture and forest.
Narragansett stony fine sandy loam				20				50	30	Hay, pasture, and forest.
Narragansett gravelly fine sandy loam				20				10	40	Do.
Gloucester stony very fine sandy loam				20				30	40	Forest and pasture.
Gloucester stony fine sandy loam				20				40	40	Do.
Gloucester stony sandy loam				10				10	20	Do.
Merrimac fine sandy loam, rolling phase				40				20	30	Hay and pasture.
Quonset sandy loam		(10)		40	(35)			10	40	Do.
Hinckley gravelly sandy loam, dark-colored phase				30	(25)			10	40	Do.
Carver loamy sand				10			20	20	30	Forest and pasture.
Hinckley gravelly sandy loam				20	(25)			10	30	Pasture and forest.
Hinckley loamy sand				20				10	20	Forest and pasture.
Whitman loam				80					40	Hay and pasture.
Whitman fine sandy loam				20					20	Pasture and forest.
Whitman silty clay loam				20					20	Do.
Mansfield silty clay loam				30					30	Do.
Peat, salt-marsh phase				50					20	Hay and pasture.
Muck and peat									10	Forest.
Muck, shallow phase									10	Do.
Tidal marsh				40					20	Hay and pasture.
Merrimac gravelly coarse sandy loam				20			10 (30)	10	20	Forest and pasture.
Carver loamy coarse sand				10					20	Do.
Coastal beach				20					20	Pasture.
Whitman stony loam									10	Forest.
Rough stony land (Gloucester soil material)									20	Do.
Dune sand									10	Do.

The rating compares the productivity of each of the soil types (or other separations on the map) in the two counties for each given crop, to a standard—100. This standard index represents the inherent productivity of the most productive soil type (or types) of significant acreage in the United States for that crop. A soil type estimated to be about half as productive for the specified crop as the type with the standard index is given the index 50. In a few instances, unusually productive soils of limited acreage will have an index above 100 for a specified crop.

The inherent productivity indexes are based on the ability of the land to produce under a system of management capable of maintaining the inherent level of productivity without the use of amendments. Under current agricultural practices in these counties, soil amendments, such as lime and commercial fertilizers, are commonly used (manure produced on the land is not considered an amendment). Under such practices, the productivity of some of the soils may rise well above the level of the index 100. In table 7 the productivity of the soil with amendments is shown by index figures in parentheses.

The factors influencing the productivity of land are mainly climate, soil, and relief, or lay of the land. Crop yields over a long period furnish the best available summation of the factors contributing to productivity. They have been used largely as the basis for the determination of the productivity indexes in this table. A low index for a particular crop may be due to some local condition of unfavorable relief, drainage, or climate rather than to a lack of fertility in the soil.

The soils are listed in the table in the approximate order of their general productivity, but no attempt has been made to place them in definite grades or classes. It must be stated clearly that this classification is not to be interpreted directly into specific land values. It is based on the essentially permanent factors of inherent productivity of the soils and their responsiveness to fertilization and management, and little consideration is given to the more transitory economic conditions. In some instances the information on which to base the ratings is not so complete as desired, and further study may suggest changes.

The following tabulation sets forth some of the acre yields which have been set up for standards of 100. When applied to the inherently most productive soil types of significant acreage, they represent long-time production averages without the use of soil amendments to alter the inherent productivity of the soil type for a product of satisfactory quality.

Crop:	
	Bushels
Corn (grain)	50
Oats	50
Potatoes	200
	Tons
Corn (silage)	12
	Pounds
Hay (except alfalfa)	4,000
Alfalfa	8,000
	Cow acre-days[1] *per year*
Pasture	100

[1] Cow acre-days is a term used to express the carrying capacity of pasture land. As used here, it is the product of the number of animal units carried per acre multiplied

MORPHOLOGY AND GENESIS OF SOILS

The region of which Kent and Washington Counties are a part was originally covered with a dense forest consisting mostly of oak, white pine, maple, ash, elm, birch, hickory, cedar, and hemlock. The oak, hickory, and hemlock grew on the well-drained ridges and upland hilltops; pine and birch, on the sandier soils of the plains and uplands; poplar, on the imperfectly drained mineral soils; and cedar, in the swamps. All the original forests have disappeared, and the existing forests consist of second- and third-growth trees.

The soils have been developed from the products of physical and chemical weathering of the glacial till and to less extent from the underlying bedrock. In the moderately cold region of New England the physical weathering consists mostly of disintegration of the rocks through freezing and thawing. The chemical weathering, or decomposition, of the rock involves a complicated series of changes due to the action of water, carbonic acid, organic matter, and other natural reagents. The rock materials in this section of New England are chiefly quartz and silicate minerals. During the processes of chemical weathering, which is speeded up during the summer months, the silicates are hydrolyzed and broken down, chiefly assisted by carbonic acid, humic acid, and other electrolytes. Other reactions take place to form compounds which may accumulate in the soil or be leached out, depending on the solubility of the compound, amount of rainfall, and soil drainage. As weathering continues, soil material is accumulated, and the presence of vegetation becomes a factor in increasing the solvent power of water by adding carbon dioxide and humic acids. Under a forest vegetation, as is characteristic of New England, the decomposing tree leaves do not provide enough bases to the surface soil for complete neutralization of soil acidity, and both organic and inorganic colloids become saturated with hydrogen. They are acid. The colloids become dispersed and move downward in the soil. Iron moves downward in solution, but as it passes out of the influence of soluble organic matter a portion or nearly all of it becomes oxidized and is precipitated in the debased B horizons.

The reactions are never complete, but they are sufficiently complete to effect a considerable accumulation of both iron and organic matter in the B horizon of the Podzol and Gray-Brown Podzolic soils.

In these counties the soil-forming processes have acted sufficiently long so that most of the soil on the nearly level land has reached a substantial degree of maturity. The precipitation, averaging about 40 inches a year, is sufficient to impress its influence on the soil characteristics. As nearly all the soils are thoroughly drained, leaching has continued during the time of their development and has caused a translocation of soluble organic and mineral constituents.

Kent and Washington Counties lie entirely within the region of Gray-Brown Podzolic soils of northeastern United States. Both the humid climate and the soils over most of the area favor rapid growth of dense vegetation, and raw humus has accumulated to some extent on the surface of virgin land or even on land once cultivated

by the number of days the animals are grazed without injury to the pasture. For example, a soil type able to support 1 animal unit per acre for 360 days of the year rates 360, whereas another type able to support 1 animal unit per 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days the rating is 25.

but now abandoned and reforested. True Podzols occur only on the sandy-textured fog-swept uplands, which provide the conditions necessary for the development of a Podzol profile in this region, and over the remainder of the uplands in places a faint development of the characteristic Podzol profile has taken place. On the level sand-covered outwash plains, because of lack of fertility, sparse vegetation, and summer heat, the accumulation of organic matter is small. The lack of fertility prevents heavy plant growth, and the heat causes the resulting organic matter to disintegrate rapidly and disappear from the surface. The amount of organic matter in the surface soil, in general, is correlated with the degree of drainage. The excessively drained soils contain the least organic matter, and those with imperfect or poor drainage contain the most. Unless fertilized, all the cultivated soils are deficient in organic matter, but they can be improved both physically and chemically by the addition of desirable organic matter.

All the soils of this area are acid, the acidity ranging from pH 4 to pH 5 in the topmost 18 inches of soil, and from pH 5 to pH 5.5 in the lower horizons. It was noticed that soils near the seacoast, like Narragansett loam, Hinckley gravelly sandy loam, dark-colored phase, and Ninigret very fine sandy loam, were darker and less acid than the soils occurring farther inland. It is probable that this difference results from the long-continued use of seaweed as a fertilizer, which has increased the organic matter as well as lessened the acidity by the addition of many small shells. The soils derived from the weathered products of the black shales, sandstones, and conglomerates of the Narragansett Bay section have a less acid subsoil than the other soils. In a few areas of the Quonset soil near East Greenwich the soil is neutral in reaction, especially below a depth of 6 or 8 inches.

Table 8 shows the pH values of two Gloucester soils and one Narragansett soil. All layers of these soils become less acid with depth, and the Narragansett soil is slightly less acid than the Gloucester soils.

TABLE 8.—*pH determinations on three soils from Kent and Washington Counties, R. I.*

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Gloucester stony sandy loam:	*Inches*		Narragansett stony loam, level phase:	*Inches*	
140221	0–1	3.8	140201	0–6	5.4
140222	1–3	4.4	140202	6–11	5.2
140223	3–4	4.4	140203	11–29	5.3
140224	4–13	4.7	140204	29–32	5.6
140225	13–28	4.9	140205	32–52	5.6
140226	28–48+	5.4	140206	52–65+	5.7
Gloucester stony very fine sandy loam:					
140227	0–3	3.4			
140228	3–4	4.1			
140229	4–14	4.6			
140230	14–30	5.1			
140231	30–60	5.1			

The diagrammatic cross section (fig. 2) of Kent County from near Pojac Point to West Greenwich Center is typical of the general distribution of the soils from east to west. It shows a close correlation between the texture of the underlying bedrock and the overlying soil

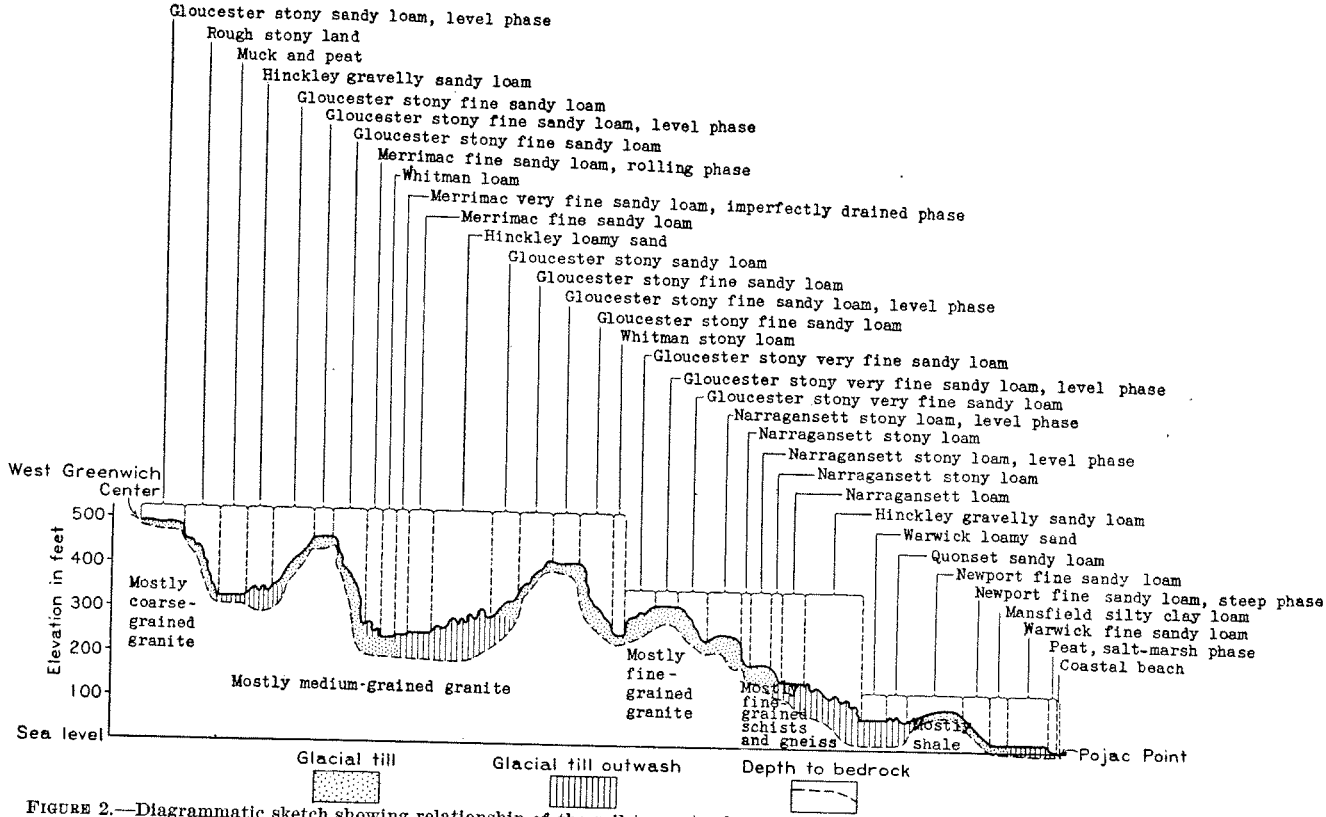

FIGURE 2.—Diagrammatic sketch showing relationship of the soil types to elevation, parent material, and depth of glacial till, from Pojac Point on the east to West Greenwich Center.

and a correlation between parent rock and soil type. Soils developed from weathered glacial drift with a high content of shale and conglomerate materials give rise to the soils of the Newport, Warwick, and Mansfield series; those from the fine-grained schist and gneiss materials give rise to soils of the Narragansett and Whitman series; and soils derived from granite and similar crystalline rock materials high in quartz give rise to the Gloucester soils. Glacial outwash plains are distributed throughout and show but little correlation with the surrounding soils, but some correlation exists between the outwash plains material in the eastern part and the adjacent shale and conglomerate hills that give rise to the Newport soils.

Following is a detailed description of a profile of Gloucester stony sandy loam, as observed 1 mile south of Watchaug Pond, in a virgin soil area supporting a second- or third-growth pine and oak forest. The relief ranges from rolling to rough. The soil here resembles the Plymouth soils as much as it resembles the Gloucester soils, but it has been mapped with the Gloucester soil. This soil is characterized by an acid heavy leaf mat, 1 inch or more thick, which rests on a light-gray acid loose high-silica layer about 2 inches thick. This has been leached of bases and colloids and is low in nitrogen, except where the partly decomposed organic matter from the layer above has been mixed with the mineral material. This layer is underlain by a more dense brown sandy loam horizon, 4 or 5 inches thick, in which iron and alumina have accumulated. The material in this layer is more compact than in any other layer in the profile. It is more reddish brown adjacent to the gray layer and becomes less brown with depth. This material gradually changes to a loose friable light yellowish-brown sandy loam layer at a depth ranging from 13 to 17 inches. The material in this layer changes rapidly to pale yellowish-brown loamy sand that, at a depth of 28 or 30 inches, rests on a slate-gray loose heterogeneous mixture of angular sand, sandy loam, and gravel. This material continues without any stratification to the underlying coarse-grained granitic bedrock. In most places the depth to bedrock is about 10 feet, but in the terminal moraine section it is much deeper.

The soil genesis of the other Gloucester soils is similar to that of Gloucester stony sandy loam. On the level areas, which are not subject to erosion, the surface soil is naturally thicker, and the subsoil is slightly deeper, but in most places on the sloping land the bedrock is near the surface. The finer textured members of the Gloucester series are heavier throughout and less leached because they are not so excessively drained. The physical properties of the soil differ with differences in texture, therefore, the very fine sandy loam has a higher water-holding capacity and higher fertility and is more productive than the sandy loam. The textural differences are partly inherited from the parent material from which the soils have been developed and are partly a result of soil-forming processes such as climate, relief, vegetation, and age.

The Narragansett soils are somewhat similar to the finer textured members of the Gloucester series. They are developed in slightly less sloping topographic positions and are derived from slightly finer grained rocks, mostly schist and granite gneiss. These two factors have influenced the soil material to a sufficient extent to

have an effect on agricultural use as well as on the development of the profile. The surface soil is slightly darker from a greater accumulation of organic matter due to the slightly heavier subsoil layer and to less perfect drainage. The B horizon is a lighter yellowish brown than the corresponding horizon in the Gloucester soils. The greatest difference between the soils of the two series is in the lower part of the B horizon and the upper part of the C horizon. At a depth ranging from 26 to 32 inches is a gray somewhat firm till that is compact in place but can readily be crushed between the fingers. In places this layer extends to a depth of many feet, but in other places it is only a foot or two in thickness. In either condition it is sufficiently cemented to restrict percolating water, causing it to flow laterally to hillside springs or seeps. Locally it is called a hardpan, but it is not impervious to water and lacks the hardness and chemical characteristics of a true hardpan. Lack of drainage has caused a slightly mottled gray and rust-brown coloring just above the C horizon. The relief has influenced the degree of drainage, and this is reflected in the profile; that is, on the flat or depressed areas the surface soil is darkest, the mottled layer is most pronounced, and the cemented layer is more compact, whereas on the sloping land the surface soil approaches the color of the Gloucester soils, the mottled layer is indistinct, and the compaction is slight.

The poorly drained soils, lying in swamplike positions, along streams, around springs, and near drainageways, have not been acted upon by the soil-forming processes to so great an extent as the better drained soils, and they are, therefore, considered as younger or more immature soils. These include the Whitman and Mansfield soils. The Whitman soils occur in granitic areas associated with the Gloucester and Narragansett soils, and the Mansfield soils occur in shale and sandstone areas associated with Newport and similar soils.

The soils of the outwash plains, like the better drained soils of the uplands, have characteristics indicating that the soil-forming processes have acted sufficiently long to develop a normal profile. This is illustrated in the following description of a profile of Bridgehampton silt loam, as observed in an exposure 1¼ miles northeast of West Kingston:

1. 0 to 8 inches, very dark grayish-brown to nearly black (when moist) or dark grayish-brown (when dry) friable silt loam which is mellow under cultivation but somewhat compact when in sod. This material is composed of a mixture of single-grained and crumb structures. The examination of a clod reveals many small pinholes which become larger with depth.
2. 8 to 14 inches, yellowish-brown to light yellowish-brown friable single-grained very fine sandy loam slightly less heavy than the surface layer. This layer contains some material resembling in color the material in the layer above, evidently translocated by boring insects. This layer gradually changes in color to the underlying layer.
3. 14 to 35 inches, olive-gray velvety very fine sandy loam, easily recognized by its striking color as compared to the yellow-colored layer above and the rich-brown layer directly below.
4. 35 to 44 inches, rich yellowish-brown or rich-brown friable single-grained very fine sandy loam. This layer seems to have a concentration of iron and possibly alumina, it is slightly heavier than the olive-gray layer above, and has some indication of a clay structure, which is lacking in all the other layers.
5. 44 to 50 inches, fine sand, coarse sand, and some fine gravel, mostly gray.

6. 50 inches +, the material becomes coarser in texture and more open in character with depth.

The material in all layers is acid in reaction, the pH in the first three layers being about 4.5 and in the last three layers about 5.5.

The heaviest textured Merrimac soils are similar to Bridgehampton silt loam, except that gravel is nearer the surface and the olive-gray layer is lacking in many places. The other outwash plains soils, even those influenced by strong glacial currents, have profiles similar to Bridgehampton silt loam. The content of coarse material, depth to gravel, and degree of drainage all differ from place to place, but the sequence of horizons is nearly the same. The surface layer is the darkest and heaviest layer of the profile, the second layer is yellow and may or may not rest on a gray layer, but the profile everywhere contains a rich-brown layer just above the stratified sand and gravel layer. This profile occurs in the Merrimac, Carver, and Bridgehampton soils, as well as in the Hinckley soils.

The soils of the eastern part of the area, in what is known as the Narragansett Basin, have somewhat different characteristics from those farther inland. This is mostly due to the parent material from which the soils have been developed and partly to the relief. This section includes the Newport soils on the uplands, the Warwick soils on the level outwash plains, the Quonset soils on the hummocky relief, and the Mansfield soils, previously described, on the poorly drained mineral soil areas.

A profile of Newport sandy loam was observed in a cultivated field one-fourth mile southwest of the railroad station at Wickford. This soil profile is typical of a normal soil in the Narragansett Basin. It is as nearly mature as any soil of the level uplands in this part of Rhode Island. The parent material (glacial till) is composed largely of shale, sandstone, and schist materials.

1. 0 to 8 inches, sandy loam, which is loose, friable, single-grained, and of unusual color, in places being somewhat green, in other places having a purple cast, and in still other places being dark gray. As observed in the profile southwest of Wickford it had a purple cast, in the adjacent cultivated field it had a dark, but not black or even very dark grayish-brown, color. Many small angular stones are on the surface and throughout the upper horizon.
2. 8 to 24 inches, friable single-grained incoherent greenish-tinged yellow sandy loam which contains many clusters of insect casts composed of dark-colored material.
3. 24 to 48 inches, a mixture of coarse sand, gravel, and sandy loam material, which ranges from greenish gray to yellowish brown and is incoherent and slightly acid.
4. 48 to 60 inches, olive-green heavier sandy loam, which is firm in place, but which readily crushes into sand particles with a somewhat green cast. The material in this layer is very slightly acid. In places this heavier layer is much nearer the surface, and the gravelly sandy layer is lacking.

All the layers contain some small black slatelike pebbles about one-fourth inch in diameter.

The Warwick and Quonset soils bear the same relationship to the Newport soils that the Merrimac and Hinckley soils do to the Gloucester and Narragansett soils. They also differ from the Merrimac and Hinckley soils, respectively, as the Newport soils differ from the Gloucester soils. The soils of the granitic region do not have

the greenish-blue shale-influenced subsoil layer that is characteristic of the soils in the Narragansett Basin.

Following is a description of a profile of Warwick loamy sand as observed one-fourth mile south of the Washington-Kent County line along the east side of the New York, New Haven & Hartford Railroad. The excavation where the soil was observed was near a good stand of black locust trees. Under the locust trees the grass was much greener, thicker, and more vigorous than the grass growing under some small pitch pine trees or in the open, less than 50 feet away.

1. 0 to 6 inches, brown friable loose incoherent heavy loamy sand which is somewhat laminated and contains many grass roots.
2. 6 to 18 inches, yellowish-brown loamy sand, very similar to the material in the layer above but containing some black rounded pebbles.
3. 18 to 30 inches, yellow fine sand containing many black flat platelike shale fragments. The material in this layer is loose, friable, and incoherent.
4. 30 inches +, olive-green slightly cemented sandy loam which is firm in place but crumbles readily when crushed between the fingers. In some places this layer may come very near the surface. This material does not interfere with rapid percolation of water or penetration of roots but seems to be beneficial, as this soil is more productive than the corresponding types of either the Merrimac series or the Carver series. The material in this layer is less acid than that in any of the layers of the Merrimac or Carver soils, because of the higher content of calcium in the parent rock from which it is derived.

TABLE 9.—*Mechanical analyses of six soils from Kent and Washington Counties, R. I.*

Soil type and sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Narragansett loam:								
140259	0–8	0.6	3.5	5.8	14.4	19.6	46.5	9.6
140260	8–18	.3	3.0	5.0	15.3	21.5	50.7	4.2
140261	18–36	.4	2.7	4.9	12.7	29.3	48.0	2.0
140262	36–40	6.6	9.4	5.9	14.1	22.2	36.9	5.0
140263	40–50+	9.3	26.0	22.4	24.2	6.6	9.4	2.0
Gloucester stony sandy loam:								
140221	0–1	11.2	18.6	12.1	23.2	13.4	18.4	3.0
140222	1–3	7.5	18.3	16.0	25.7	13.2	13.5	5.9
140223	3–4	9.6	21.8	17.2	25.3	11.6	11.5	2.9
140224	5–13	12.7	19.3	14.3	22.2	12.5	14.9	4.1
140225	13–28	13.2	19.5	14.1	22.8	11.8	15.4	3.3
140226	28–48+	17.1	28.1	18.4	23.7	8.3	3.3	1.0
Newport fine sandy loam:								
140264	0–8	3.7	10.5	12.9	24.9	16.0	24.2	7.7
140265	8–24	4.4	11.5	15.2	25.3	13.5	22.0	8.1
140266	24–48	8.5	15.3	22.7	27.0	11.6	11.7	3.1
140267	48–60+	5.2	10.0	12.4	27.2	15.6	24.6	4.9
Hinckley gravelly sandy loam:								
140217	0–5	10.1	17.6	12.0	16.8	13.3	23.3	6.9
140218	5–13	10.7	20.1	14.8	18.5	10.1	21.0	4.9
140219	13–30	32.0	37.4	13.5	11.5	2.4	1.4	1.9
140220	30–80+	32.6	37.5	12.6	9.7	2.6	2.9	2.1
Bridgehampton silt loam:								
140240	0–8	2.0	3.8	3.1	4.3	10.8	65.6	10.3
140241	8–14	1.8	2.7	2.1	3.4	12.6	76.1	1.2
140242	14–35	.5	.7	.7	1.3	14.1	80.7	2.0
140243	35–44	2.0	3.6	2.6	4.4	13.0	65.0	9.4
140244	44–50+	16.4	35.4	20.7	11.2	5.5	8.7	2.0
Merrimac loamy sand:								
140250	0–6	6.0	12.6	14.7	32.1	13.0	14.8	6.7
140251	6–12	7.2	11.9	14.6	34.3	11.6	13.5	6.9
140252	12–18	6.2	10.3	16.5	42.6	11.5	10.6	2.4
140253	18–48	6.5	14.0	24.0	36.4	11.3	6.3	1.5
140254	48–60+	29.6	30.6	16.6	15.4	3.2	3.8	.8

Soil-forming processes have only slightly influenced the less extensive immature soils, such as dune sand and coastal beach.

The organic soils do not differ essentially from other organic soils throughout New England and the Lake States. Fringing the swamps adjacent to coarse-textured sandy plains soils in many places, a shallow muck or peat layer overlies a thick layer of bleached sand that rests on an iron ortstein layer ranging from 2 to 4 inches in thickness. This indurated layer usually is at or near the level of the water table. In areas adjacent to heavier textured plains or upland soils, the muck or peat layer rests on gray or gray and brown mottled heavy-textured material.

Table 9 gives the results of mechanical analyses of six soils.

SUMMARY

Kent and Washington Counties, comprising a total area of 499 square miles in the southern part of Rhode Island, include about one-half the area of the State.

Physiographically the area is comprised of two distinct divisions—the eastern or Narragansett Basin division, and the western hilly division. The elevation ranges from sea level in the Narragansett Basin to a height of 610 feet in the northwestern corner of Kent County.

The climate is humid, being characterized by medium-cold wet winters, short medium-warm summers, and wet cool spring and fall months. The fairly cool summer climate, as well as the beautiful summer resorts, makes this area very popular with summer tourists.

Hay is the leading crop, followed by corn, potatoes, vegetables harvested for sale, and oats, ranking in acreage in the order named. In 1930 only about 20 percent of the area of the two counties was in crops, including land in pasture and fruit trees. Most of the remaining 80 percent of the area was in forest.

Dairying is the most important type of farming, with poultry raising second, both types being concentrated near the larger towns.

Rhode Island is one of the most densely populated States in the Union, but despite this fact the State contains large tracts of forest land seldom traversed by man. Nearly 97 percent of the population is urban.

The counties lie in the region of Gray-Brown Podzolic soils of northeastern United States and were once covered with forests of pine and hardwood. The entire section has been covered with a mantle of glacial drift of variable thickness, and the mineral soils have been influenced by the glacial till and to less extent by the underlying rocks.

From east to west across the area a correlation exists between the soils, the parent material, and the agricultural use.

In the eastern, or Narragansett Basin, division the soils have been derived to some extent from the weathering of shales and conglomerates. The dominant soils are the Newport in the uplands, the Warwick on the level plains, the Quonset on the hummocky areas, and the Mansfield in poorly drained areas along the drainageways. This division comprises the best agricultural farm land in the two counties. The Newport soils are used extensively for hay and pasture, Kentucky bluegrass being the dominant permanent pasture

grass with a small proportion of Rhode Island bentgrass. The Warwick soils are productive for hay and especially productive for truck crops. The Quonset soils are used for producing hay. The Mansfield soils produce grass and forest trees.

Inland from this group of soils is a narrow belt of soils derived directly or indirectly from the weathered fine-grained granite gneiss and schists, which give rise to the Narragansett and Ninigret soils on the uplands, the Bridgehampton soils on the plains, and the heavy-textured Whitman soils on the poorly drained upland areas. This section is also considered good agricultural farm land but, on the average, is not quite so desirable as the section to the east.

The Narragansett soils, although good for permanent pasture, support less Kentucky bluegrass and more bentgrass than the Newport soils, and they also support some fine-leaved fescue. The level areas are as productive for cultivated crops as any of the uplands in the two counties. Ninigret very fine sandy loam, occurring near the southern coast, is used similarly to the level areas of the Narragansett soils. The Bridgehampton soils are the best soils in the State for growing potatoes. The heavy-textured Whitman soils are used only for pasture and for forest.

In the western hilly division the soils have been influenced by coarse- and medium-grained granite and other crystalline rocks. These soils include the Gloucester in the uplands, the Merrimac and Carver on the level plains, the Hinckley on the hummocky land, the light-textured Whitman on the imperfectly drained land, and muck and peat in the swamps. The Gloucester soils are used mostly for forest, depending on the slope of the land and the texture of the surface soil. The level areas and more heavy textured soils are used for cultivated crops and hay, but the yields are less than on the Newport and Narragansett soils. Permanent pastures support a dominant growth of fescue with a smaller proportion of bentgrass and some Kentucky bluegrass in the more moist areas. The heavier textured types of the Merrimac soils are used to good advantage for truck crops and for general farm crops. Most of the other soils mentioned are used for forest.

Coastal beach, dune sand, tidal marsh, peat, salt-marsh phase, and rough stony land are nonagricultural or are used to only a very small extent for agriculture.

All the soils of the area surveyed are acid, except where they have been heavily limed, but the soils in the eastern and southern parts are the least acid. Thus, the Gloucester, Hinckley, Merrimac, and Carver soils are more acid than the Narragansett soils which, in turn, are more acid than the Newport, Warwick, Quonset, and Ninigret soils. All the very wet soils are very acid, the organic soils being more acid than the mineral soils.

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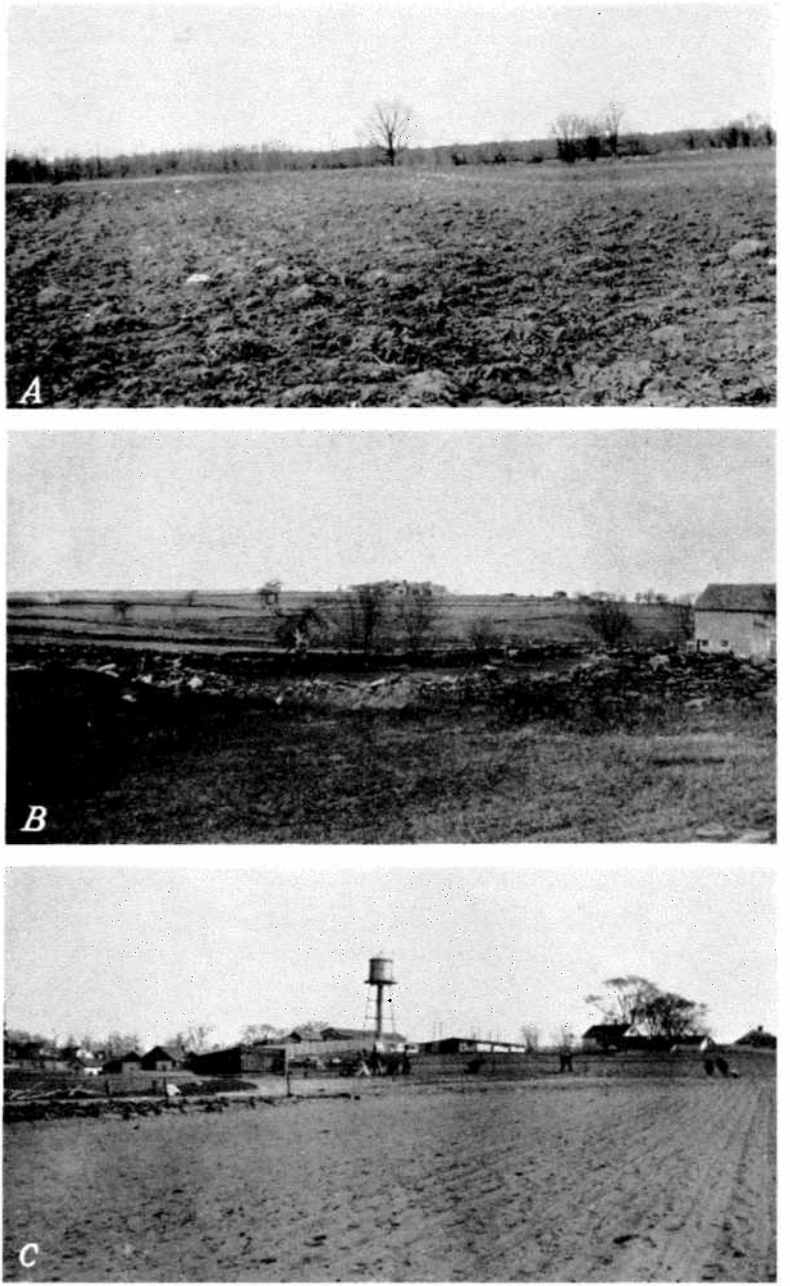

A, Plowed field of Narragansett loam near Peace Dale; *B*, typical rural scene on Newport loam; *C*, planting truck-garden seeds on Merrimac fine sandy loam.

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